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INVESTIGATION OF
A HIGHLY LOADED
TWO-STAGE FAN-DRIVE TURBINE

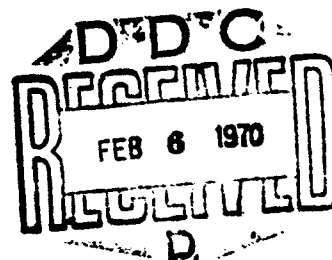
VOLUME II. Phase II, Part 1. Preliminary Experimental Evaluation

H. Welna, D. E. Dahlberg and W. H. Heiser

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AFAPL-TR-69-92
VOLUME II

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INVESTIGATION OF
A HIGHLY LOADED
TWO-STAGE FAN-DRIVE TURBINE

VOLUME II. Phase II, Part 1. Preliminary Experimental Evaluation

H. Welna, D. E. Dahlberg and W. H. Heiser
Pratt & Whitney Aircraft
Division of United Aircraft Corporation

Technical Report
AFAPL-TR-69-92 Volume II
December 1969

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FOREWORD

(U) This Interim Technical Status Report (Contractors Reference No. PWA-3576) was prepared by Pratt & Whitney Aircraft, Division of United Aircraft Corporation, East Hartford, Connecticut, as the second Semiannual Report under United States Air Force Contract F33615-68-C-1208, Project No. 3066, Task No. 306606. This report was submitted by the Contractor on 31 December 1968, and covers the Report period from 1 July 1968 to 31 December 1968.

(U) The findings and conclusions of this report are not deemed as final by the Contractor. They are subject to verification or revision in the Final Report to be published upon the completion of this Contract.

(U) The Air Force Program Monitor is Mr. Jack Richens, APTC, Air Force Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio, 45433.

(U) This report contains no classified information extracted from other classified documents.

(U) Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

Wayne Tall
Project Engineer
Air Force Aero Propulsion Laboratory

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UNCLASSIFIED ABSTRACT

(U) A comprehensive three-year program is in progress to investigate methods of improving the performance of fan-drive turbines. The goals of the program are to develop turbine aerodynamic techniques and design procedures for efficient, high work, low pressure turbines by means of analytical studies and cascade testing, and to demonstrate the effectiveness of the techniques by designing and testing a two stage turbine that meets or exceeds the contract stage work and efficiency goals. The first phase effort defining the preliminary turbine design has been completed and the results have been reported. The second phase consists of a preliminary experimental evaluation which includes establishment of two-dimensional loss levels and three-dimensional flow behavior for both the baseline airfoils and airfoils utilizing boundary layer control devices. The design of the rig hardware and the baseline airfoils which will be evaluated during this second phase are presented in this report.

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LIST OF SYMBOLS

A	- area, square inches
B	- axial chord, inches
C	- absolute gas velocity, feet per second
C _F	- drag coefficient
C _L	- Zweifel load coefficient
C _L [*]	- load coefficient, $\Delta C_u/U$
E	- diffusion parameter
H	- boundary layer shape factor
ΔH	- work, Btu per pound
M	- Mach number
P	- pressure, psia
ΔP	- pressure rise from minimum to exit value on suction surface
Q	- exit dynamic head
R	- fillet radius, inches
R _C	- radius of curvature, inches
Re _{θ}	- Reynolds number based on boundary layer momentum thickness
S	- distance along airfoil surface, inches
T	- temperature, °R
u	- tangential velocity, feet per second
W	- relative gas velocity, feet per second
W _g	- gas flow, pounds per second
X	- axial distance, inches
Y	- tangential distance, inches
Z	- number of airfoils
α	- absolute gas angle, degrees
β	- relative gas angle degrees
δ	- boundary layer thickness, inches
δ^*	- boundary layer displacement thickness
θ	- boundary layer momentum thickness, inches
θ_b	- blade camber, degrees
θ_v	- vane camber, degrees
τ	- gap, inches
η	- efficiency, percent

Subscripts

0	inlet to first vane
1	inlet to first blade
2	exit from stage or airfoil section

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LIST OF SYMBOLS (Cont'd)

G	gage point
ws	wetted surface
ms	mainstream surface
S	static
T	total

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SECTION I INTRODUCTION

(U) Aircraft jet engine performance and optimization studies have always included a trade-off between increasing turbine efficiency and reducing the turbine weight. Recently, the bypass turbofan engine has dominated jet engine applications. For this type of engine, the economy generally increases with increasing bypass ratio. However, increased bypass ratios represent increased fan power requirements, which must be met by increased fan-drive turbine power. It is, therefore, necessary to meet these increased turbine loading requirements without penalizing the turbine efficiency.

(U) The fan-drive turbine design is constrained by certain unique requirements. The rotational speed of the turbine must be limited in order that the fan tip Mach number does not exceed the limit for reasonable losses. As the bypass ratio and, therefore, the fan diameter increase, this problem becomes even more critical. Applying conventional aerodynamics, as limiting turbine rotational speeds are approached, increased work can only be realized by increasing the number of stages and/or the turbine diameter. Reduction of the turbine diameter or solidity results in a lighter turbine, but with a sacrifice in efficiency due to losses associated with increased loading. Considerable gains can be realized by an engine if the size and weight reduction can be made with no loss in efficiency. Because of the time required between the evolution of new concepts and engine production, turbine technology must be improved now, so that the desired level of turbofan engine performance can be achieved for aircraft which will be operational in the 1975-1980 time period.

(U) The objective of the work done under this contract is to analyze and test concepts which will increase the low pressure turbine loading and maintain or increase current turbine efficiency levels. The goals of this program are to develop turbine aerodynamic techniques and design procedures for efficient high work, low pressure turbines by means of analytical studies and cascade testing, and to demonstrate the effectiveness of the techniques, by designing and testing a two-stage turbine that meets or exceeds the contract stage work and efficiency goals.

(U) The total program has been planned in four phases over a period of three years. Phase I defined the basic turbine design and an analysis of promising increased loading concepts was completed. The results of the Phase I study is reported in Reference 1 and briefly summarized in Section I of this report. Phases II and III consist of experimental testing to verify and extend the turbine aerodynamic techniques and design procedures for high loading levels. Phase IV will subject the aerodynamic techniques and design procedures to a two-stage rotating rig test.

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(U) Work on this contract during the reporting period proceeded on Phase II. The design and fabrication of both the annular segment and plane cascade airfoils and test rigs has been conducted as scheduled. This report describes this effort. Sufficient test airfoil and rig design details are included for permanent record in order that this hardware can be duplicated in the future, if necessary. Testing has been initiated and the results will be reported in the next Interim Technical Report.

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SECTION II BACKGROUND

(U) The Phase I analysis of this contract has been completed and the results are described in Reference 1. The objective of Phase I was to select a preliminary turbine design that is capable of meeting the performance requirements specified in this Contract (See Table I). The final choice of the preliminary turbine configuration was based on the judgments formed from the analyses generated during Phase I. These analyses included consideration of the flow-path, reaction level, load coefficient level, and variations in work distribution for which velocity triangles were generated.

(U) Preliminary airfoil contours were defined for the velocity triangles for three levels of reaction and three levels of solidity for equal work split stages. Based on the resulting two-dimensional suction surface pressure coefficients and diffusion parameters, the following preliminary airfoils were selected for contour refinement: first vane, first blade and second vane - normal, medium and low solidity; second blade - normal and medium solidity. The selected preliminary airfoil contours were refined further to improve the pressure distribution and increase resistance to flow separation. Modifications of the contours required several iterations on each section to arrive at the desired pressure distribution. Two-dimensional boundary layer calculations were made for the final refined contours. Based on these analyses, the design system has indicated that a number of turbine configurations are capable of meeting the performance requirements of this contract. In particular, the medium reaction, normal solidity turbine promises to meet the required goals. This design was chosen for preliminary evaluation during Phases II and III. For convenience, the pertinent parameters for the chosen design are presented in Tables II and III. As part of Phase II, these baseline airfoils will be tested to determine the nature and extent of the end loss mechanism before selecting, designing, and testing appropriate boundary layer control techniques.

TABLE I

TURBINE DESIGN PARAMETERS

Number of Stages	2
Average Load Coefficient, C_L^*	2.2
First Blade Tip Wheel Speed	1000 fps
First Blade Inlet Hub-Tip Diameter Ratio	≤ 0.8
Exit Swirl Angle - Without Exit Guide Vane	20°
- With Exit Guide Vane	0°
Turbine Inlet Temperature	1450°F
Airflow	≥ 50 lb/sec
Average Stage Efficiency	91%
Life	10,000 hr.

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TABLE II

FIRST STAGE TURBINE DATA - MEDIUM REACTION

Inlet Total Pressure (P_{t0}) (psia)	-	105.0	
Inlet Total Temperature (T_{t0}) (°R)	-	1910.0	
Gas Flow (W_g) (lbs/sec)	-	67.7	
Total/Total Efficiency (η_{tt})	-	90.5	
Turbine Work (ΔH) (Btu/lb.)	-	67.3	
	<u>Root</u>	<u>Mean</u>	<u>Tip</u>
Stage Total Pressure Ratio (P_{t0}/P_{t2})	1.88	1.85	1.80
Vane Static Pressure Ratio (P_{s0}/P_{s1})	1.66	1.54	1.42
Blade Static Pressure Ratio (P_{s1}/P_{s2})	1.32	1.30	1.34
Vane Inlet Gas Angle (α_0)	64.1	59.6	61.6
Vane Exit Gas Angle (α_1)	26.5	22.7	18.3
Vane Camber (θ_v)	89.4	97.7	100.1
Blade Inlet Gas Angle (β_1)	37.6	39.0	45.4
Blade Exit Gas Angle (β_2)	24.7	24.7	24.7
Blade Camber (θ_b)	117.7	116.3	109.9
Stage Exit Swirl Angle	40.2	52.1	66.4
Blade Inlet Absolute Gas Velocity (C_1)	1820.0	1654.0	1481.0
Blade Exit Absolute Gas Velocity (C_2)	1082.0	822.0	695.0
Blade Inlet Relative Gas Velocity (W_1)	1214.0	928.0	834.0
Blade Exit Relative Gas Velocity (W_2)	1699.0	1499.0	1414.0
Blade Inlet Tangential Velocity (U_1)	701.0	835.0	961.0
Blade Exit Tangential Velocity (U_2)	701.0	862.0	1005.0
Blade Reaction ($(s_1 - P_{s2}/P_{s0} - P_{s2})$)	25.9	30.1	37.3
Vane Inlet Absolute Mach Number (M_{0ab})	0.345	0.290	0.279
Vane Exit Absolute Mach Number (M_{1ab})	0.949	0.854	0.770
Blade Inlet Relative Mach Number (M_{1rel})	0.622	0.469	0.317
Blade Exit Relative Mach Number (M_{2rel})	0.890	0.780	0.730
Interstage Axial Mach Number	0.371	0.320	0.296

TABLE III

SECOND STAGE TURBINE DATA - MEDIUM REACTION

Inlet Total Pressure (P_{t0}) (psia)	-	56.8	
Inlet Total Temperature (T_{t0}) (°R)	-	1663.1	
Gas Flow (W_g) (lbs/sec)	-	67.7	
Total/Total Efficiency (η_{tt})	-	91.5	
Turbine Work (ΔH) (Btu/lb.)	-	67.2	
	<u>Root</u>	<u>Mean</u>	<u>Tip</u>
Stage Total Pressure Ratio (P_{t0}/P_{t2})	1.88	2.05	2.09
Vane Static Pressure Ratio (P_{s0}/P_{s1})	1.37	1.56	1.4
Blade Static Pressure Ratio (P_{s1}/P_{s2})	1.32	1.51	1.61
Vane Inlet Gas Angle (α_0)	37.3	50.0	61.9
Vane Exit Gas Angle (α_1)	30.6	24.3	22.6
Vane Camber (θ_v)	112.1	105.5	95.5
Blade Inlet Gas Angle (β_1)	45.4	47.1	67.0
Blade Exit Gas Angle (β_2)	37.0	28.9	22.3
Blade Camber (θ_b)	97.6	104.0	90.7
Stage Exit Swirl Angle (α_2)	57.7	57.9	59.8
Blade Inlet Absolute Gas Velocity (C_1)	1799.0	1570.0	1355.0
Blade Exit Absolute Gas Velocity (C_2)	1178.0	917.0	711.0
Blade Inlet Relative Gas Velocity (W_1)	1242.0	824.0	508.0
Blade Exit Relative Gas Velocity (W_2)	1655.0	1591.0	1586.0
Blade Inlet Tangential Velocity (U_1)	693.0	691.0	1090.0
Blade Exit Tangential Velocity (U_2)	693.0	906.0	1112.0
Blade Reaction ($P_{s1} - P_{s2}/P_{s0} - P_{s2}$)	30.3	40.8	48.5
Vane Inlet Absolute Mach Number (M_{0ab})	0.554	0.365	0.292
Vane Exit Absolute Mach Number (M_{1ab})	1.003	0.869	0.765
Blade Inlet Relative Mach Number (M_{1rel})	0.696	0.446	0.269
Blade Exit Relative Mach Number (M_{2rel})	0.944	0.904	0.892
Interstage Axial Mach Number	0.568	0.433	0.337

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SECTION III

TWO-DIMENSIONAL DESIGN VERIFICATION (TASK IIa)

1. RFP OBJECTIVE

- (U) Provide an experimental verification of the two-dimensional design characteristics.

2. TASK OBJECTIVE

- (U) The purpose of this Task is to conduct plane cascade tests in order to verify the aerodynamic concepts applied to the turbine design during the Phase I program, and to establish the two-dimensional loss levels for the chosen turbine airfoil profiles at design conditions.

- (U) The plane cascade tests will serve two, equally important, purposes. First, the measured profile losses will be compared with those contained in the computer programs to verify the existing design procedures. Second, the total pressure and flow angle profiles at the exit plane will indicate whether or not the surface boundary layer has separated. Each airfoil has been designed so that such two-dimensional separation should not occur, and these tests will constitute a verification of the separation criterion used in the airfoil design.

3. AIRFOIL SECTION AND RIG DESIGN

- (U) A summary of the pertinent airfoil design parameters for the selected baseline turbine as a result of Phase I study are shown in Table IV. The six airfoil sections to be initially tested are the mean section of each airfoil row and the second vane and blade root sections. These profiles will be individually evaluated in order to verify the predicted two-dimensional losses. The cascade packs will consist of straight airfoils having the contours of their respective baseline airfoil design. The airfoil sections are shown in Figures 1 through 6. The dimensions listed in these figures and the coordinates for the airfoils (see the Appendix) show the engine size values. In order to permit a reasonable amount of surface static pressure taps to be installed on the plane cascade airfoils, scaled up airfoils were fabricated for plane cascade testing. Scale factors were 1.840, 2.012, 2.123, 1.921, 2.067, 2.066, for the first vane mean, first blade mean, second vane root, second vane mean, second blade root, second blade mean airfoils, respectively.

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TABLE IV

MEDIUM-REACTION NORMAL-SOLIDITY AIRFOIL SUMMARY

<u>First Stage Vane</u>	<u>No. of Foils</u>	<u>Exit Mach Number, M_2</u>	<u>$\Delta P/Q$</u>	<u>Max. Surface Mach Number</u>
Root	62	0.949	0.313	1.150
1/4 Root	62	0.891	0.244	1.036
Mean	62	0.852	0.213	0.966
1/4 Tip	62	0.820	0.195	0.918
Tip	62	0.770	0.192	0.859
<u>First Stage Blade</u>				
Root	116	0.890	0.279	1.058
1/4 Root	116	0.849	0.296	1.020
Mean	116	0.788	0.331	0.968
1/4 Tip	116	0.738	0.294	0.883
Tip	116	0.730	0.236	0.840
<u>Second Stage Vane</u>				
Root	80	1.003	0.337	1.230
1/4 Root	80	0.920	0.277	1.094
Mean	80	0.870	0.227	0.999
1/4 Tip	80	0.821	0.196	0.928
Tip	80	0.765	0.203	0.865
<u>Second Stage Blade</u>				
Root	126	0.944	0.408	1.233
1/4 Root	126	0.922	0.324	1.136
Mean	126	0.904	0.263	1.067
1/4 Tip	126	0.897	0.236	1.040
Tip	126	0.892	0.224	1.025

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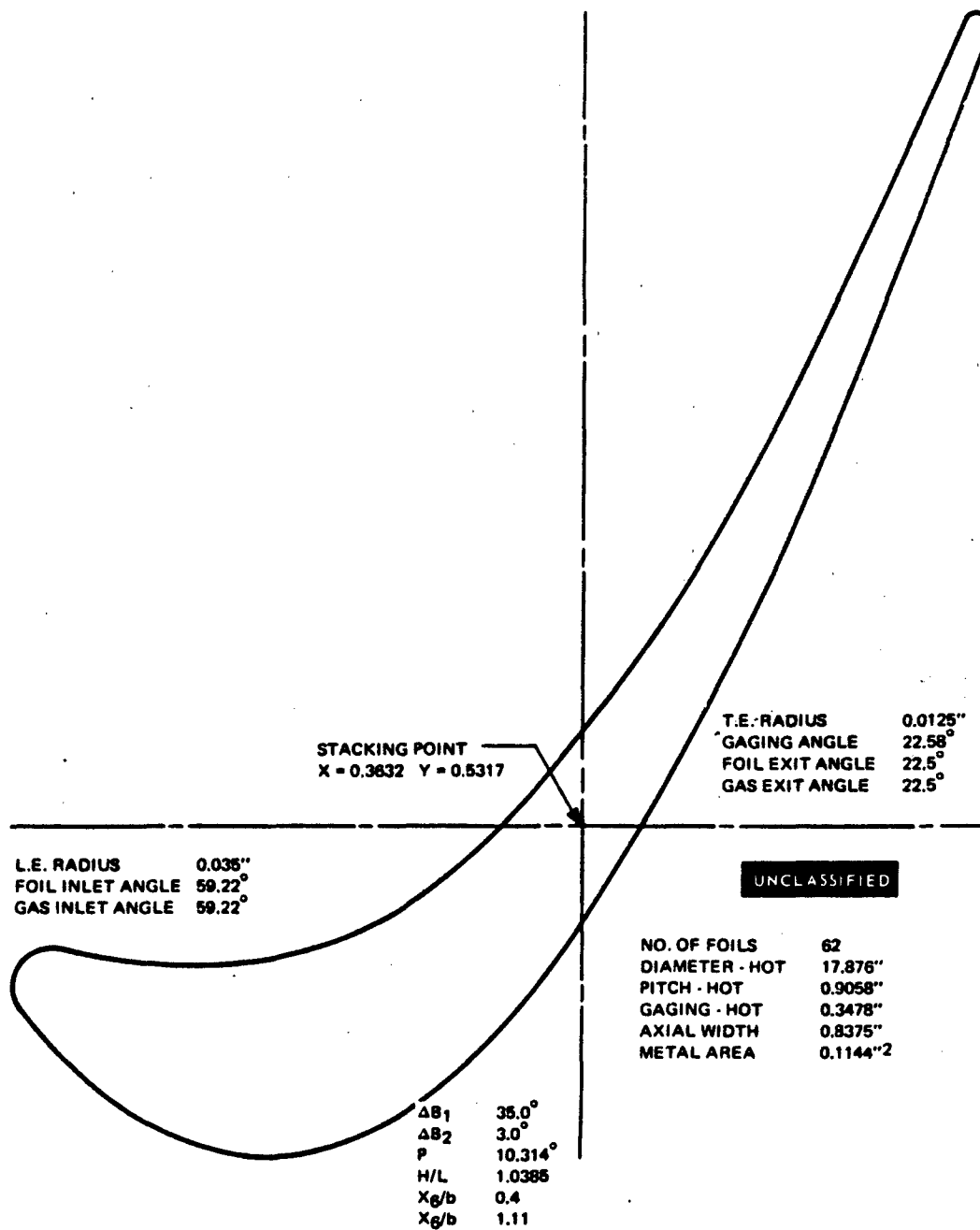


Figure 1 Medium Reaction, Normal Solidity, Final First Stage Vane Mean

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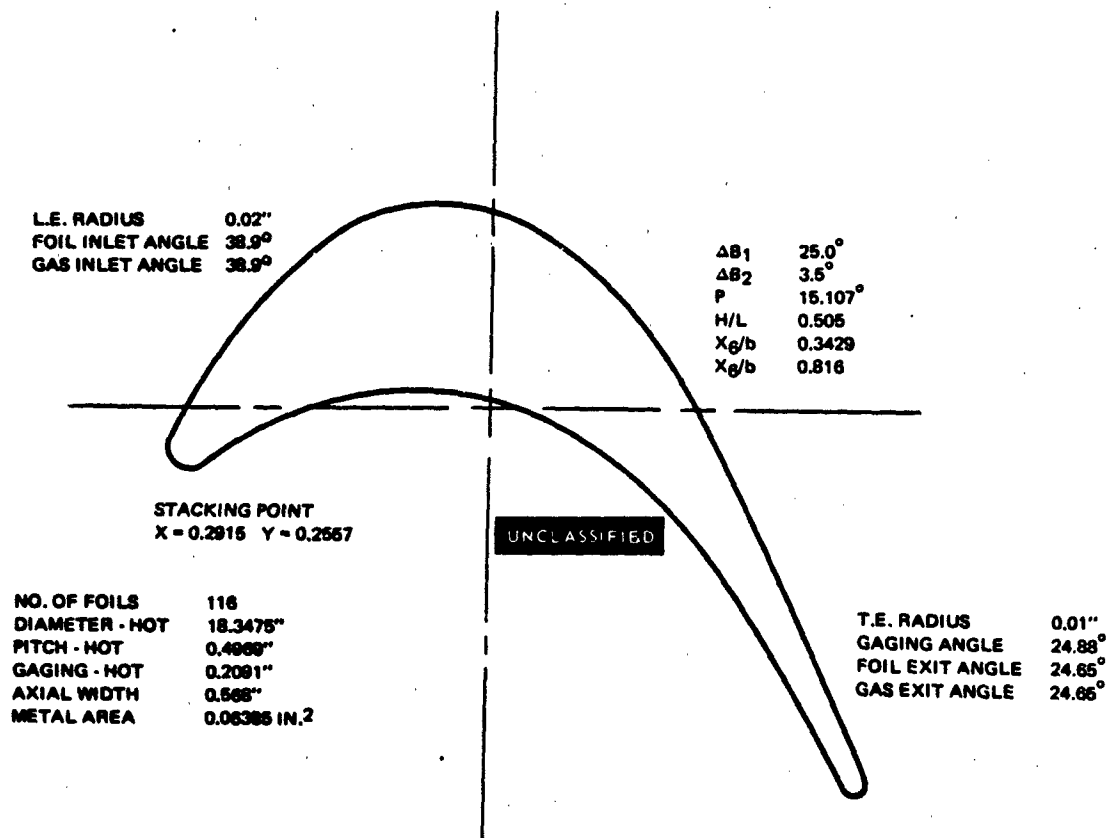


Figure 2 Medium Reaction, Normal Solidity, Final First Stage Blade Mean

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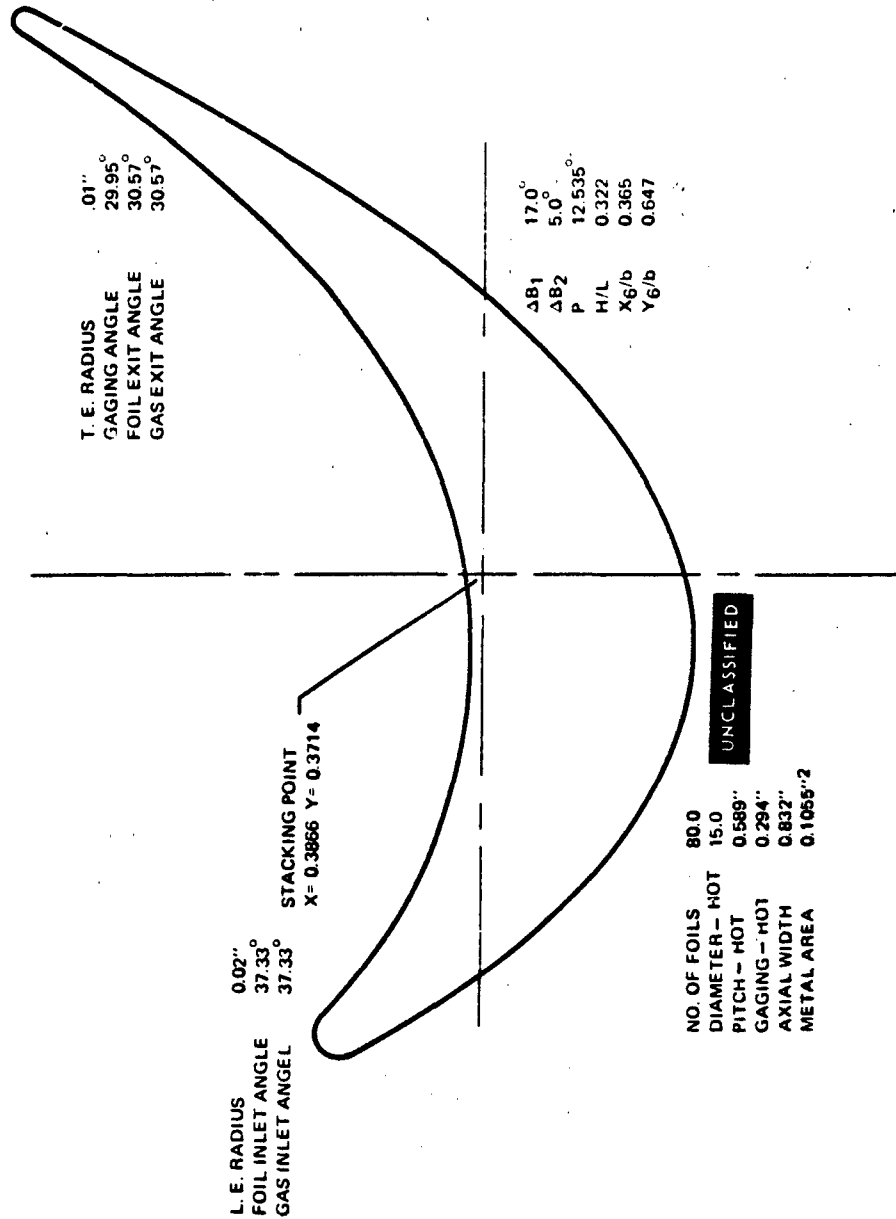


Figure 3 Medium Reaction, Normal Solidity, Final Second Stage Vane Root

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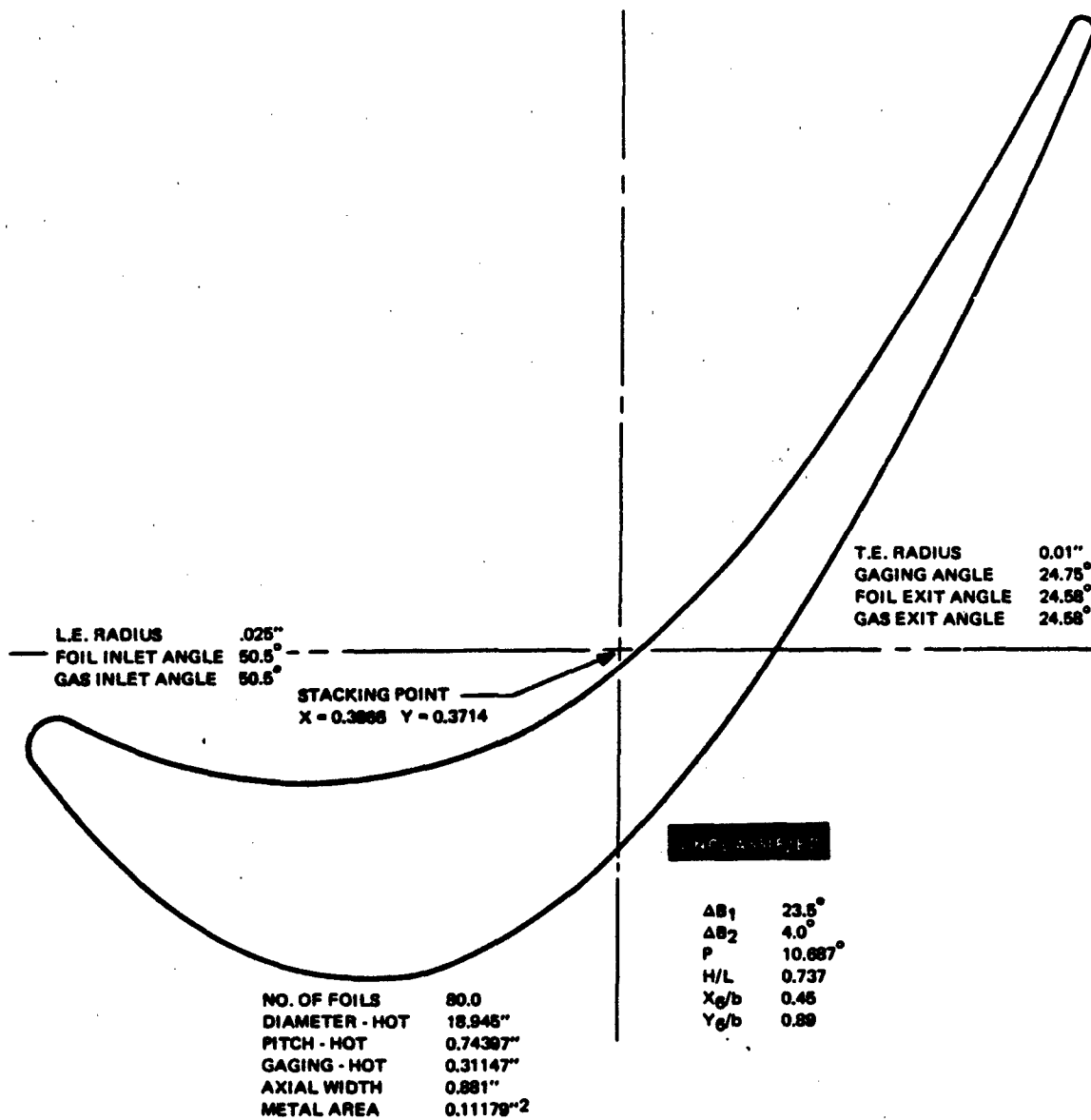


Figure 4 Medium Reaction, Normal Solidity, Final Second Stage Vane Mean

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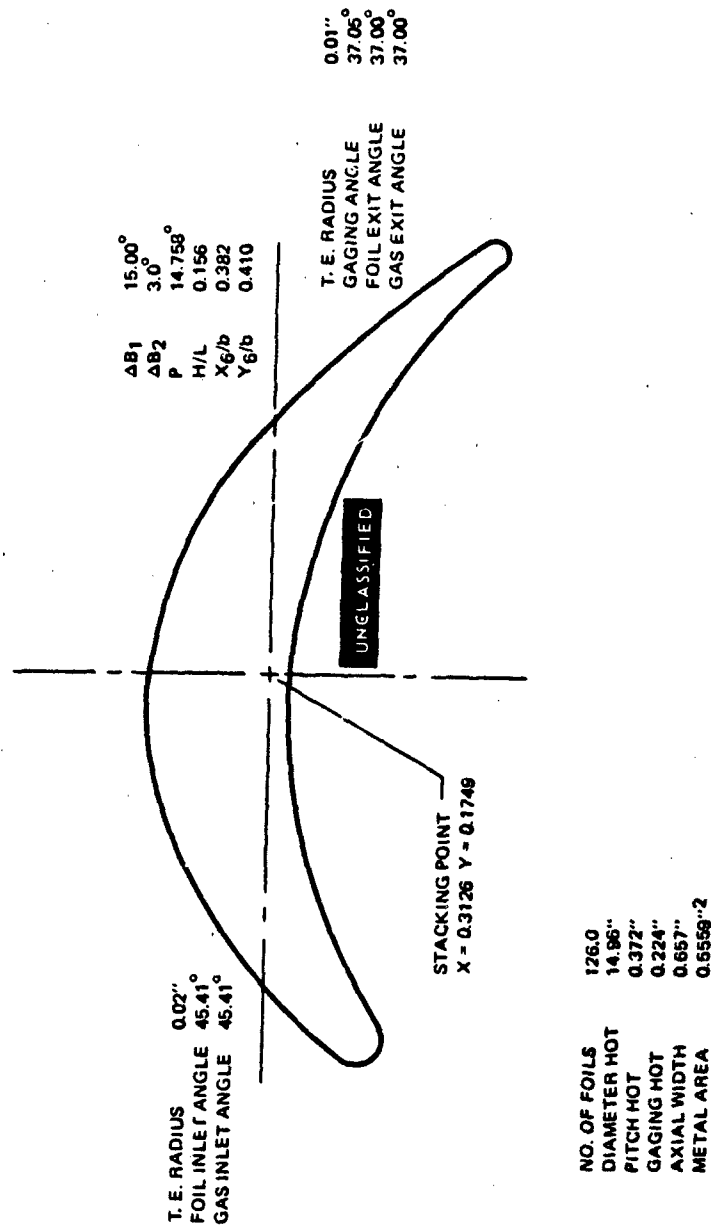


Figure 5 Medium Reaction, Normal Solidity, Final Second Stage Blade Root

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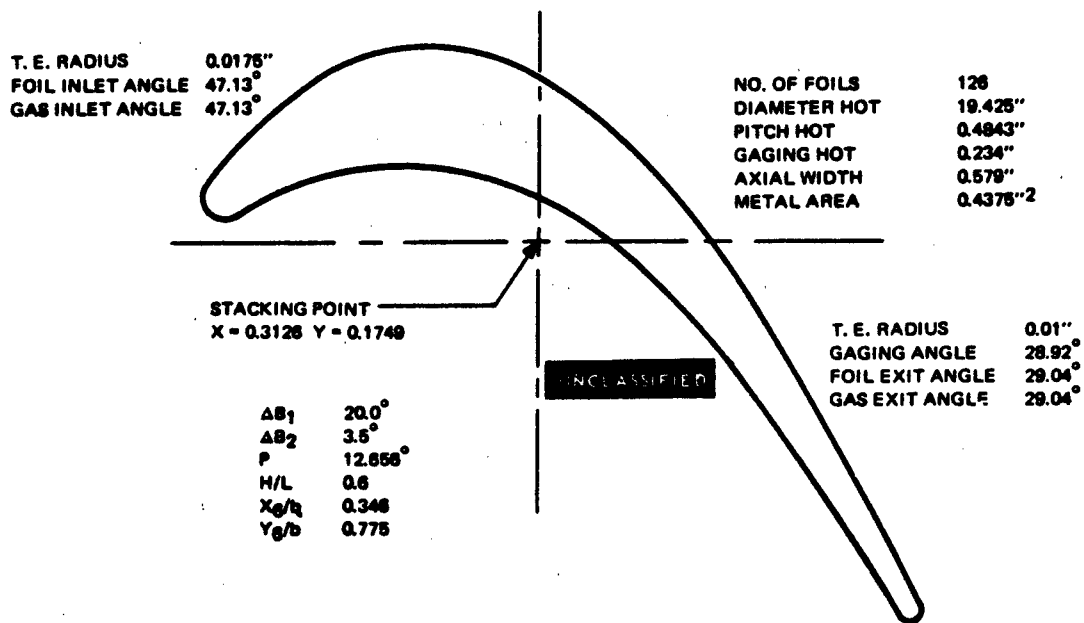


Figure 6 Medium Reaction, Normal Solidity, Final Second Stage Blade Mean

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- (U) The method of assembly of the cascade test packs is shown in Figure 7 and sketches of each of the individual test packs are shown in Figures 8 thru 13. All packs have airfoils with a span of 7.0 inches. The axial chords are 1.54, 1.14, 1.76, 1.69, 1.35, and 1.19 inches for the first vane mean, first blade mean, second vane root, second vane mean, second blade root and second blade mean airfoils, respectively. The gaps, the stagger angles, and the number of airfoils for each pack are also shown on the assembly sketch, Figure 7. Locations of the exit static taps are also shown for each pack, as well as the airfoil which will have surface static pressure taps, in Figures 8 thru 13. The method of installing of the airfoil surface static pressure taps and their locations for each of the test packs are shown in Figure 14. A total of 25, 20, 15, 16, 17 and 13 surface taps are installed in the first vane mean, first blade mean, second vane root, second vane mean, second blade root and second blade mean airfoils, respectively. The number of surface taps depended on the fabrication limitations imposed by each airfoil chord size.
- (U) The design of the plane cascade rig and the location of the test section on the test stand are shown in Figure 15. Inlet static pressure taps will be installed on the test rig rather than on each test cascade as in the case of the exit static taps. The test section will have a variable inlet and exit flow path in order that all six cascades can be evaluated using basically the same hardware. The variable geometry rig design will permit each cascade to be tested at its respective design incidence angle. Both inlet and exit pressures can be independently controlled, as well as the inlet temperature level, allowing the correct simulation of inlet and exit Mach numbers, as well as the design Reynolds number. The cascade pack exit total pressure and exit flow angle profiles will be measured. Based on these measurements, profile loss coefficients will be determined for the midspan of the instrumented airfoil in the cascade. Local and integrated loss coefficients will be calculated for the test passage width. These midspan profile losses will be compared with the turbine mean line loss as predicted by the design system. The root section profile loss will be compared with the two-dimensional design prediction, verifying its characteristics without the end wall influences.

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	1ST VANE MEAN	1ST BLADE MEAN	2ND VANE ROOT	2ND VANE MEAN	2ND BLADE ROOT	2ND BLADE MEAN
A	1.930	1.535	2.170	2.093	1.768	1.594
B	2.321	1.365	1.331	2.011	.963	1.483
C	1.501	1.108	1.759	1.657	1.393	1.182
D	12.508	11.559	11.567	12.205	11.231	11.709
E	.100	.100	.100	.100	.100	.100
F	.745	.745	.745	.745	.745	.745
T	1.667	1.000	1.250	1.429	.769	1.000
No. of Folds	7	11	9	8	14	11
θ	45° 0'	4° 15'	67° 15'	45° 30'	88° 0'	59° 40'

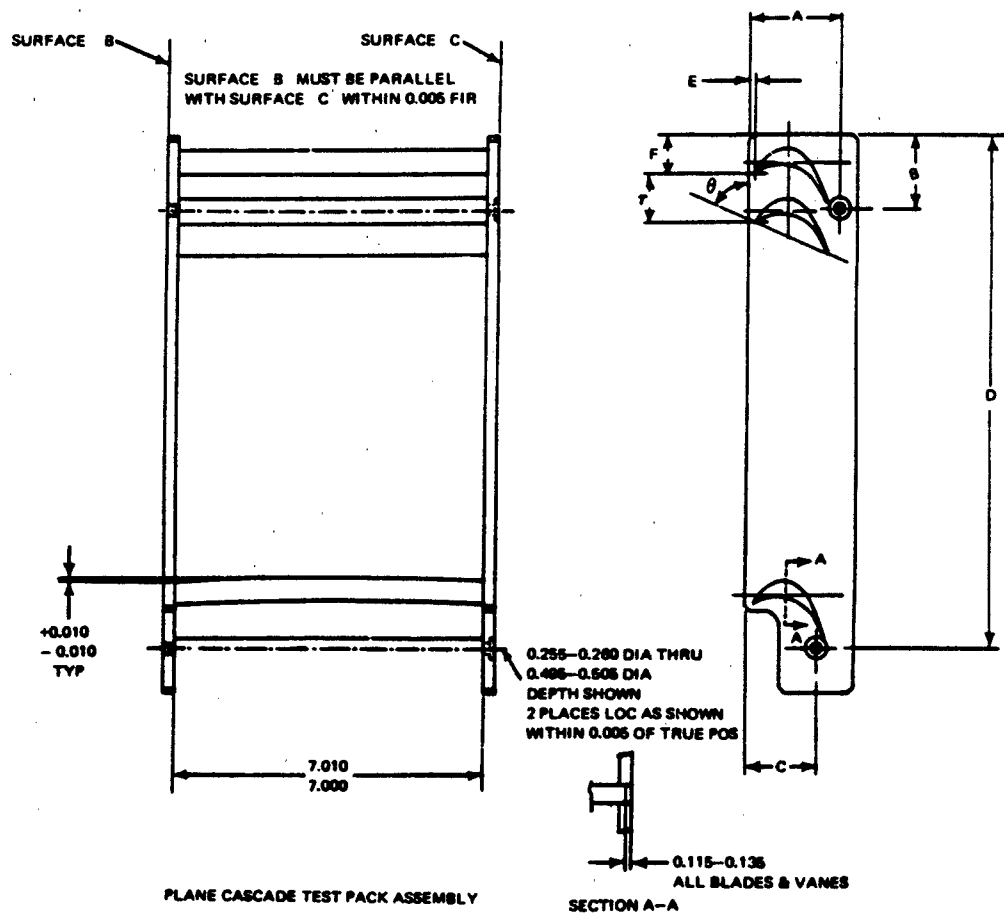


Figure 7 Plane Cascade Test Pack Assembly

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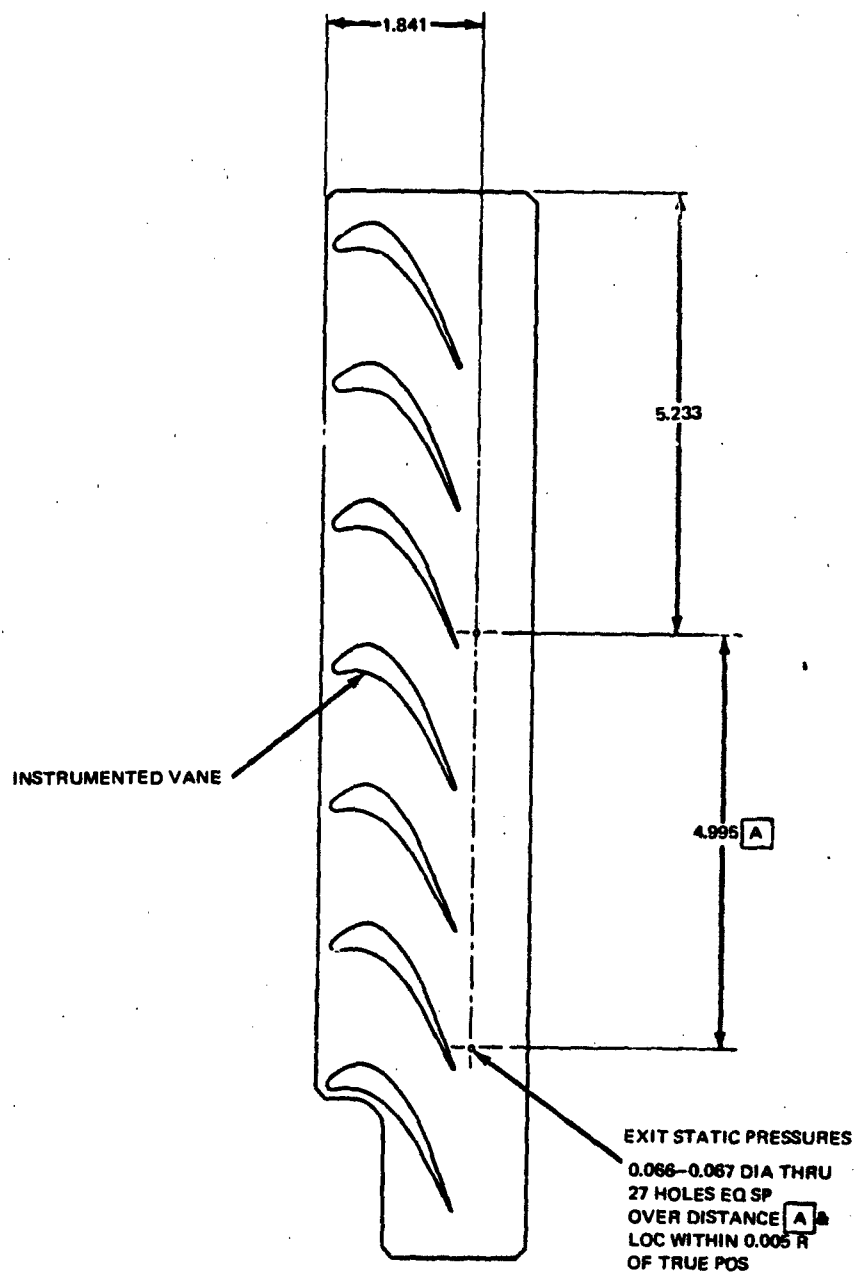


Figure 8 1st Stage Vane, Mean Section

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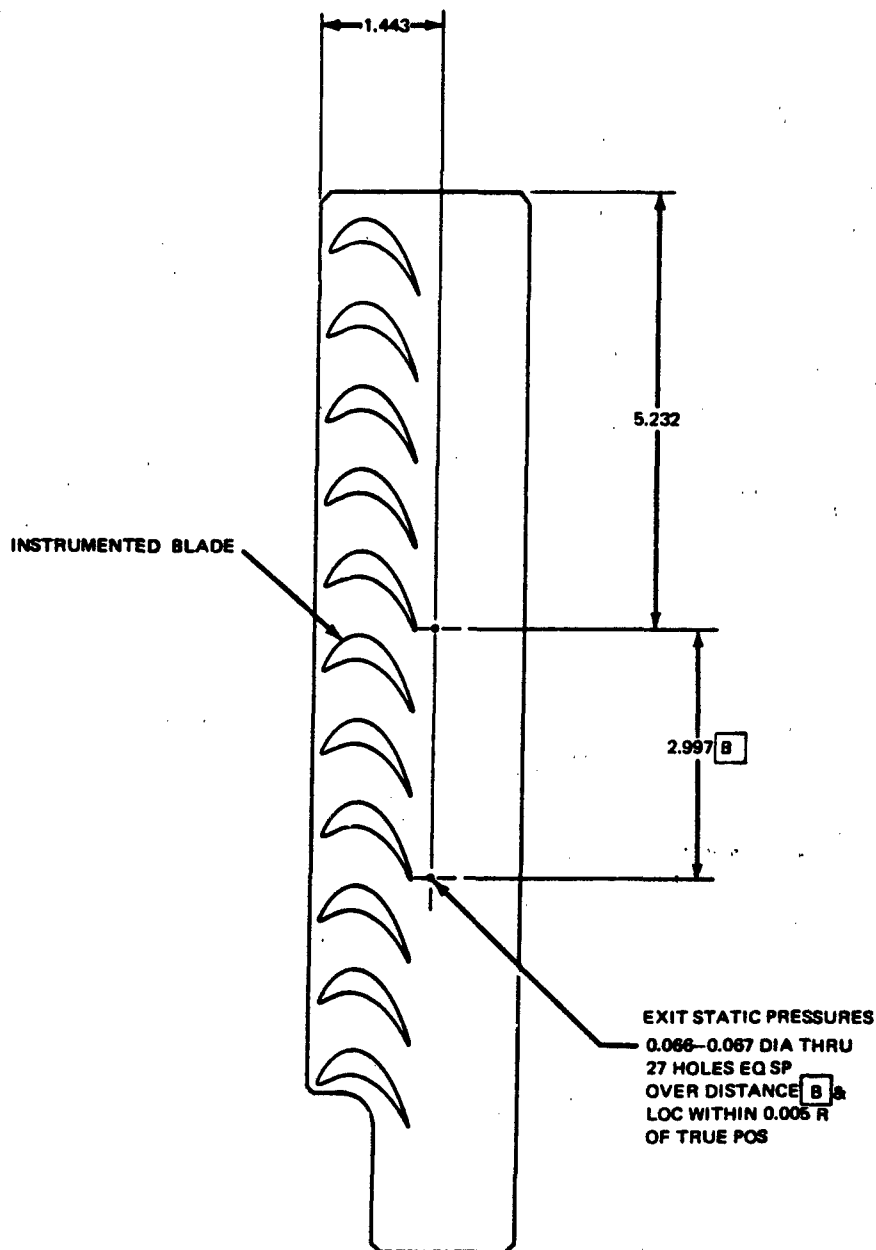


Figure 9 1st Stage Blade, Mean Section

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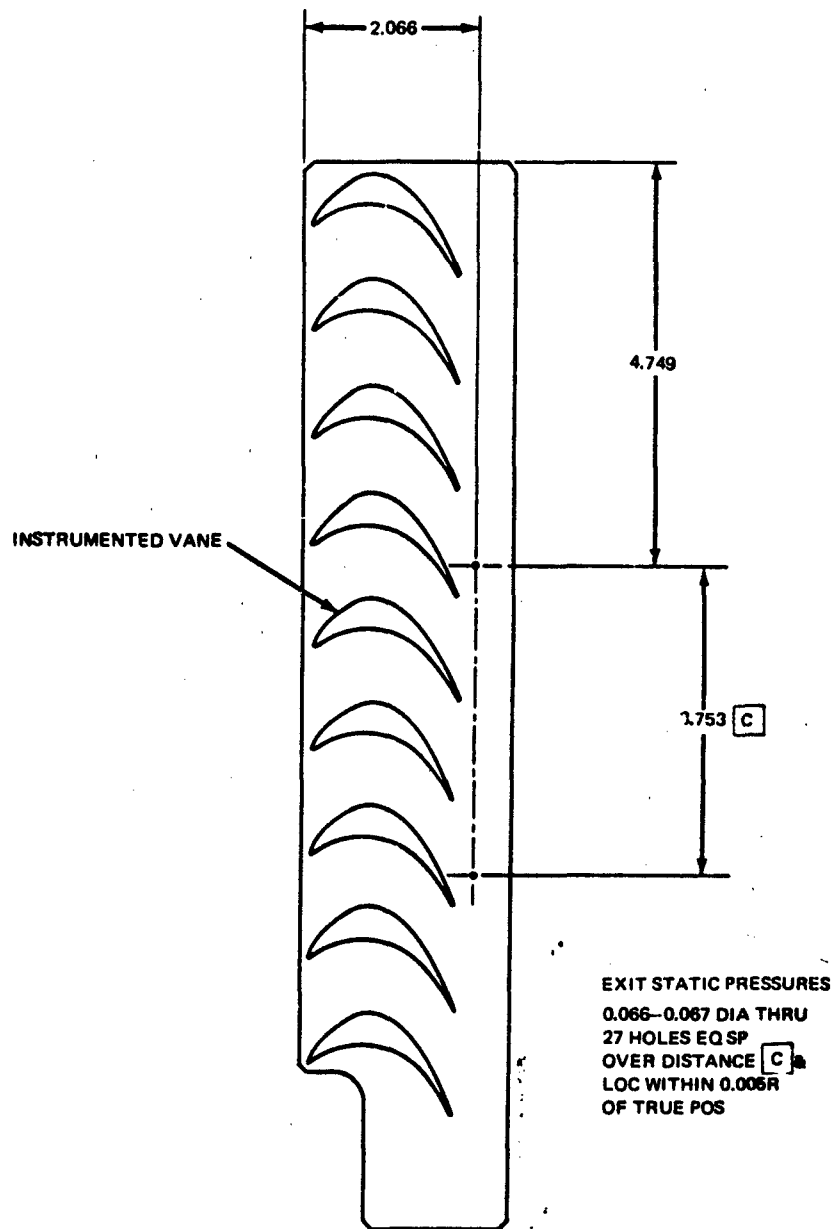


Figure 10 2nd Stage Vane, Root Section

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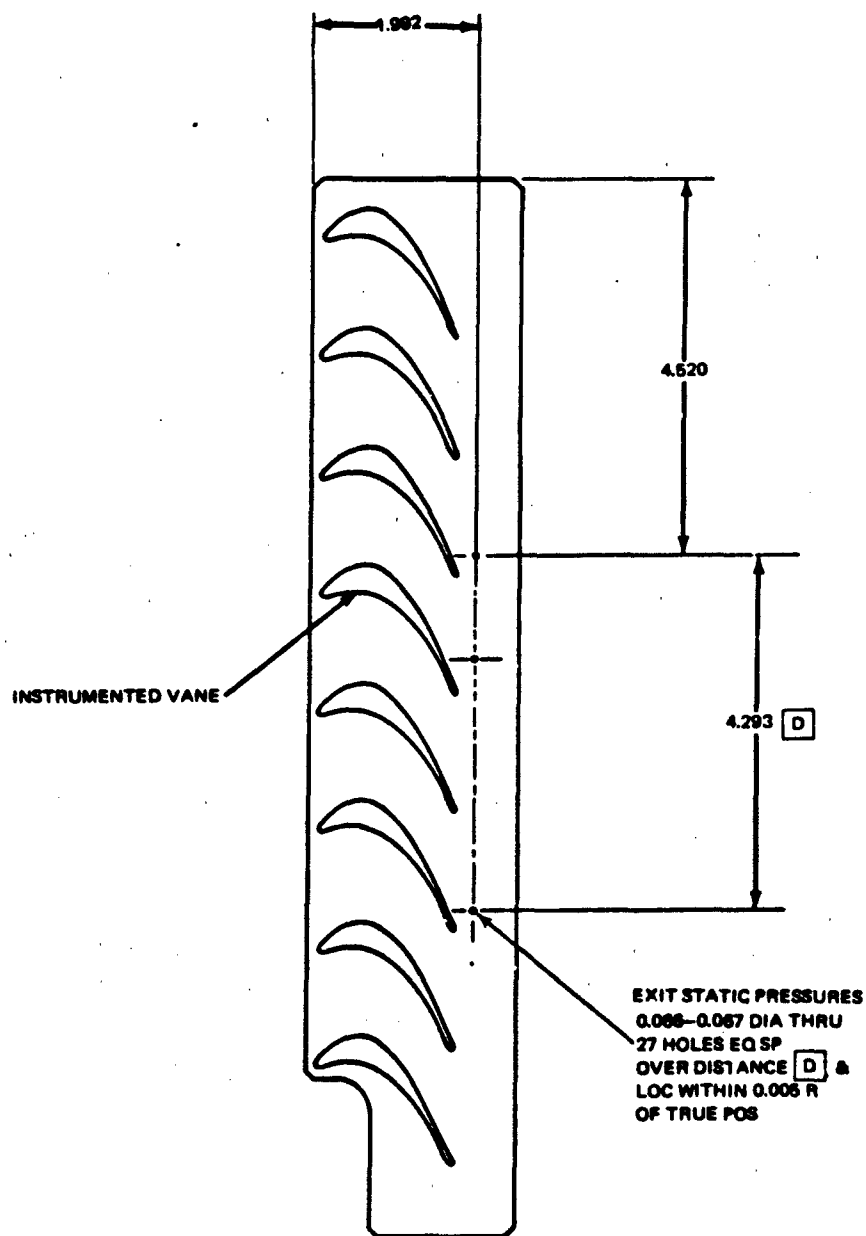


Figure 11 2nd Stage Vane, Mean Section

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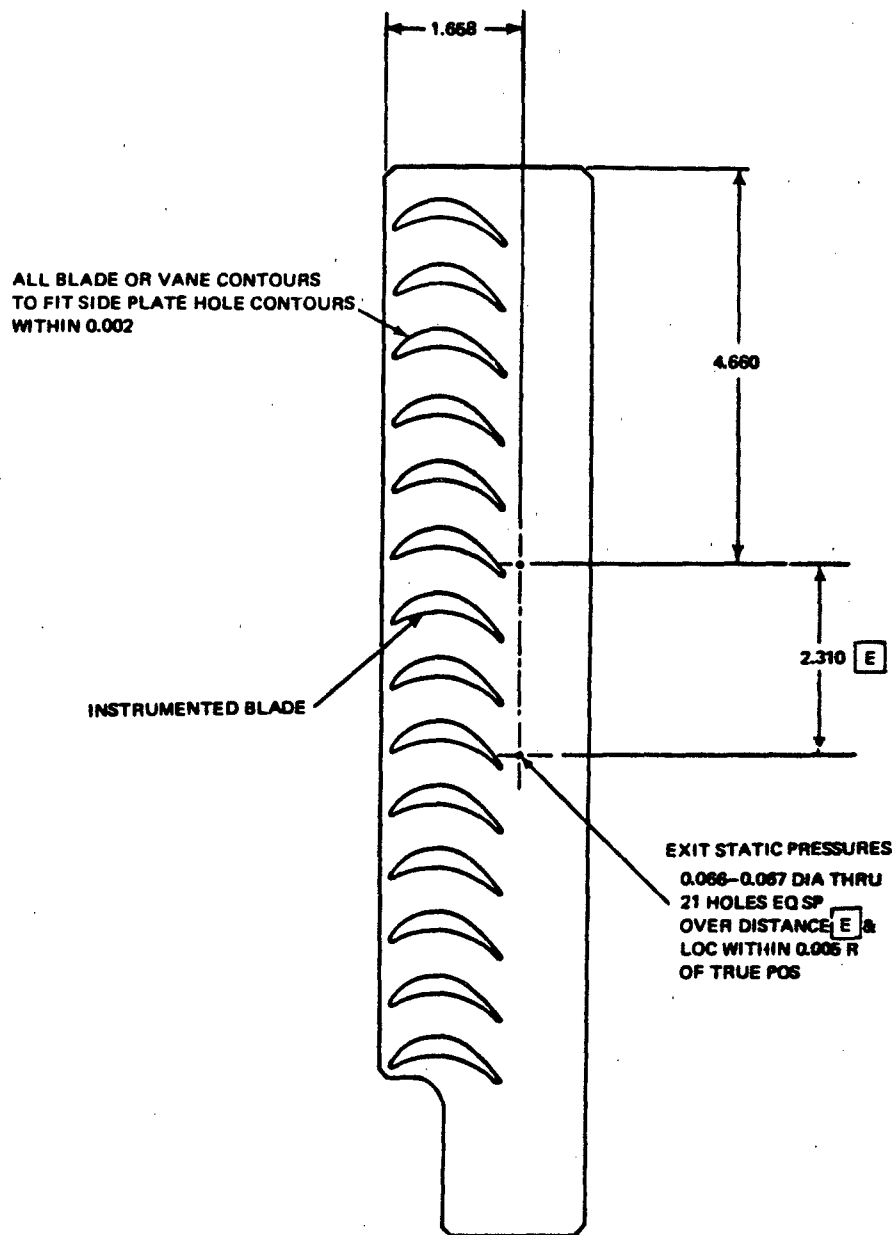


Figure 12 2nd Stage Blade, Root Section

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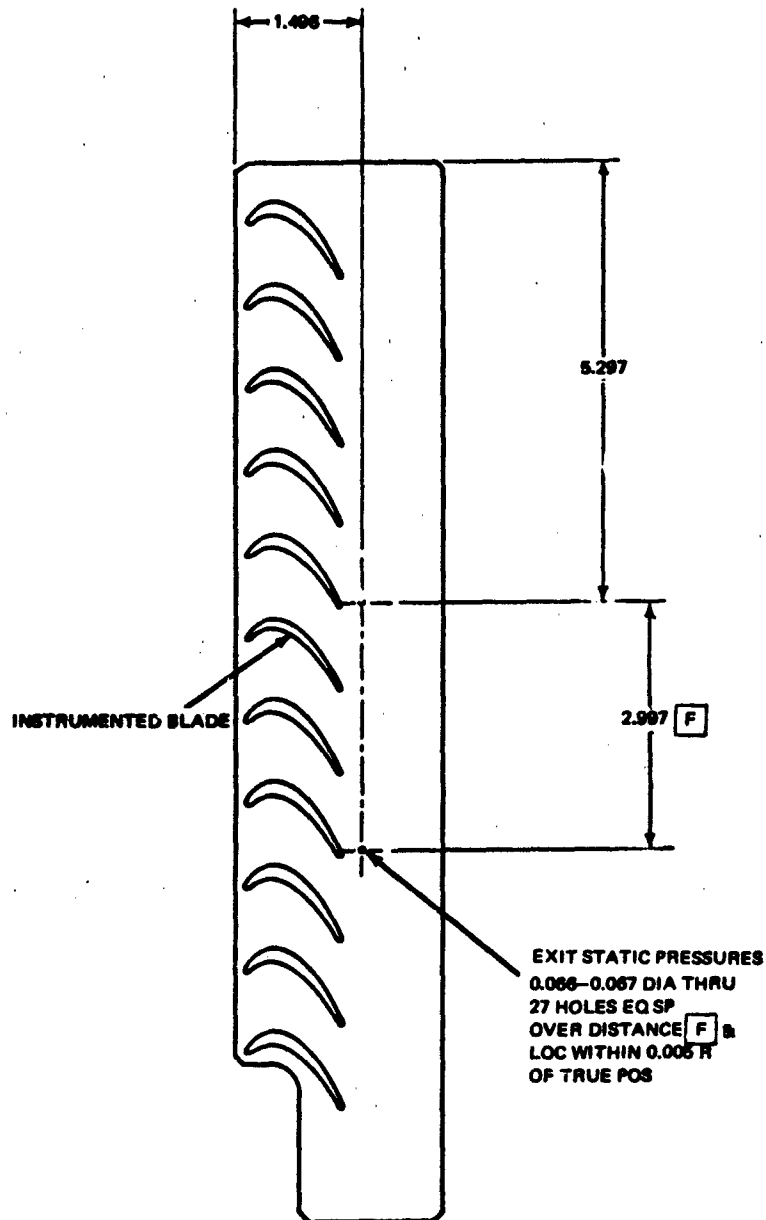
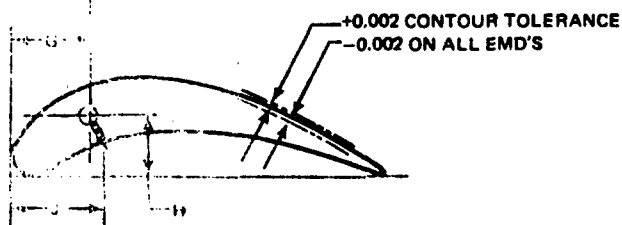
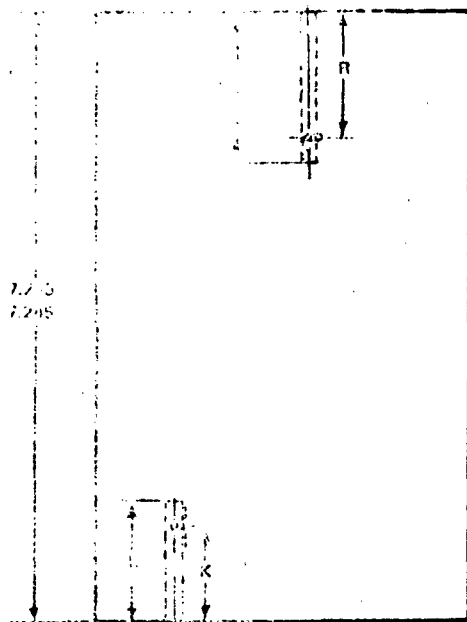
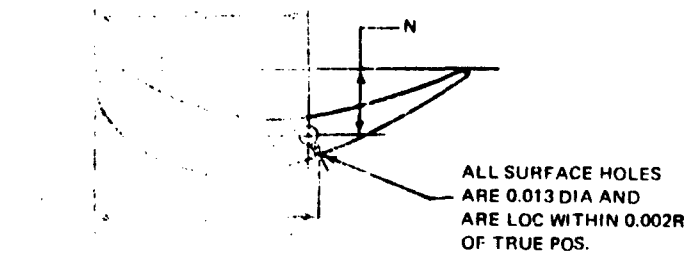


Figure 13 2nd Stage Blade, Mean Section

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FIRST STAGE VANE MEAN SECTION ALL TAP

TAP No.	G	H	J	K	L	M
1	.046	.094	.001	2.765	2.890	
2	.060	.030	.051	2.734	2.859	
3	.097	.051	.121	2.713	2.838	
4	.536	.434	.552	2.563	2.688	
5	1.000	.415	.990	2.445	2.570	
6	1.590	.251	1.577	2.282	2.407	
7	2.098	.053	2.084	2.138	2.263	
8	2.118	.035	2.189	2.125	2.250	
9			.100			.082
10			.012			.042
11						.088
12						.129
13						.266
14						.269
15						.352
16						.522
17						.762
18						.883
19						1.061
20						1.408
21						1.781
22						1.884
23						1.976
24						2.059
25						2.138

FIRST STAGE BLADE MEAN SECTION ALL TAP

TAP No.	G	H	J	K	L	M
1	.040	.040	.062	2.511	2.636	
2	.073	.096	.107	2.487	2.612	
3	.351	.184	.381	2.394	2.518	
4	.632	.393	.624	2.327	2.452	
5	.949	.250	.931	2.259	2.363	
6	.628	.044	1.214	2.149	2.274	
7	1.219	.034	1.275	2.125	2.250	
8			.031			.040
9						.045
10						.076
11						.111
12						.185
13						.280
14						.418
15						.593
16						.817
17						.923
18						1.034
19						1.148
20						1.206

SECOND STAGE VANE - ROOT SECTION - ALL TAP

TAP NO.	G	H	J	K	L	M
1	.852	.065	.091	2.675	2.800	
2	.486	.472	.451	2.542	2.647	
3	.993	.562	.980	2.397	2.522	
4	1.425	.363	.397	2.276	2.401	
5	1.739	.109	1.753	2.259	2.384	
6	1.820	.071	1.852	2.125	2.250	
7			.058			.041
8						.106
9						.317
10						.549
11						.753
12						1.109
13						1.561
14						1.708
15						1.820

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MEAN SECTION - ALL TAPS NORMAL TO SURFACE

	K	L	M	N	P	R	S	HOLE SIZE
01	2.765	2.890						.031
02	2.754	2.859						.043
03	2.713	2.818						.062
04	2.563	2.688						.043
05	2.645	2.570						.025
06	2.282	2.407						.031
07	2.138	2.263						.043
08	2.125	2.250						.025
09			.082	.036		2.961	2.891	.031
10			.042	.048		2.842	2.961	.043
11			.088	.147	.090	2.803	2.961	.062
12			.129	.146	.043	2.743	2.961	.043
			.264	.388	.162	2.697	2.961	.062
			.269	.489	.223	2.697	2.961	.043
			.352	.444	.317	2.697	2.961	.062
			.522	.533	.525	2.743	2.961	.043
			.62	.485	.780	2.743	2.961	.062
			.883	.472	.903	2.842	2.961	.043
			1.063	.422	1.084	2.4	2.961	.062
			1.408	.118	1.428	2.138	2.961	.043
			1.783	.178	1.798	2.250	2.961	.062
			1.884	.138	1.896	2.250	2.961	.043
			1.976	.101	1.987	2.250	2.961	.062
			2.059	.067	2.070	2.250	2.961	.043
			2.138	.036	2.148	2.125	2.961	.062

MEAN SECTION - ALL TAPS NORMAL TO SURFACE

	K	L	M	N	P	R	S	HOLE SIZE
2	2.511	2.636						.031
7	2.487	2.612						.043
8	2.393	2.518						.062
9	2.327	2.452						.043
1	2.239	2.363						.025
3	2.149	2.274						.031
5	2.125	2.250						.043
			.040	.040		2.637	2.961	.062
			.045	.093		2.604	2.961	.043
			.076	.145	.006	2.593	2.961	.062
			.111	.230	.022	2.566	2.961	.043
			.185	.407	.110	2.511	2.961	.062
			.280	.485	.247	2.457	2.961	.043
			.418	.491	.432	2.407	2.961	.062
			.593	.458	.627	2.353	2.961	.043
			.817	.335	.852	2.281	2.961	.062
			.923	.270	.952	2.247	2.961	.043
			1.034	.193	1.056	2.211	2.961	.062
			1.148	.107	1.165	2.172	2.961	.043
			1.266	.062	1.221	2.151	2.961	.062

ROOT SECTION - ALL TAPS NORMAL TO SURFACE

	K	L	M	N	P	R	S	HOLE SIZE
2	2.675	2.800						.031
7	2.542	2.667						.043
8	2.397	2.522						.062
9	2.276	2.401						.043
1	2.259	2.384						.025
3	2.125	2.250						.031
			.041	.041		2.845	2.970	.062
			.106	.193	.040	2.768	2.893	.043
			.317	.558	.237	2.635	2.780	.062
			.509	.664	.503	2.568	2.693	.043
			.753	.695	.777	2.494	2.619	.062
			1.109	.588	1.155	2.383	2.508	.043
			1.561	.259	1.591	2.231	2.356	.062
			1.700	.143	1.722	2.183	2.308	.025
			1.830	.071	1.799	2.153	2.278	.025

SECOND STAGE VANE MEAN SECTION - ALL TAPS NORMAL TO SURFACE

TAP NO	G	H	J	K	L	M	N	P	R	S	HOLE SIZE
1	.047	.048	.950	2.727	2.852						.031
2	.059	.158	.146	2.699	2.824						.043
3	.233	.573	.741	2.515	2.640						.062
4	1.213	.441	1.215	2.385	2.510						.043
5	1.496	.068	2.091	2.125	2.250						.025
6			.072			.047	.048		2.879	3.004	.031
7						.080	.154	.010	2.817	2.942	.043
8						.130	.259	.030	2.784	2.909	.062
9						.257	.448	.148	2.703	2.828	.043
10						.402	.554	.359	2.616	2.741	.062
11						.550	.581	.552	2.583	2.708	.043
12						.762	.582	.790	2.519	2.644	.062
13						1.048	.507	1.078	2.418	2.543	.043
14						1.528	.310	1.550	2.298	2.423	.062
15						1.893	.121	1.906	2.187	2.312	.025
16						1.986	.068	1.998	2.158	2.283	.025

SECOND STAGE BLADE ROOT SECTION - ALL TAPS NORMAL TO SURFACE

TAP NO	G	H	J	K	L	M	N	P	R	S	HOLE SIZE
1	.040	.042	.074	2.506	2.631						.031
2	.090	.112	.134	2.484	2.609						.043
3	.155	.143	.197	2.463	2.588						.062
4	.225	.218	.240	2.443	2.568						.043
5	.655	.366	.659	2.333	2.458						.062
6	1.102	.223	1.082	2.217	2.342						.043
7	1.247	.123	1.230	2.171	2.296						.025
8	1.320	.056	1.374	2.125	2.250						.031
9			.045			.040	.042		2.607	2.732	.043
10						.100	.112	.046	2.557	2.682	.062
11						.159	.178	.113	2.531	2.656	.043
12						.462	.343	.424	2.427	2.552	.062
13						.762	.361	.766	2.335	2.460	.043
14						.953	.305	.996	2.267	2.392	.062
15						1.102	.223	1.138	2.219	2.344	.043
16						1.277	.096	1.296	2.161	2.286	.025
17						1.320	.056	1.336	2.146	2.271	.025

SECOND STAGE BLADE MEAN SECTION - ALL TAPS NORMAL TO SURFACE

TAP NO	G	H	J	K	L	M	N	P	R	S	HOLE SIZE
1	.036	.037	.072	2.520	2.645						.031
2	.067	.109	.107	2.503	2.648						.043
3	.331	.371	.532	2.370	2.495						.062
4	1.042	.200	1.018	2.230	2.355						.043
5	1.317	.051	1.387	2.125	2.250						.025
6			.054			.036	.037		2.615	2.740	.031
7						.067	.109	.014	2.672	2.797	.043
8						.210	.305	.142	2.497	2.622	.062
9						.570	.370	.590	2.370	2.495	.043
10						.648	.352	.690	2.343	2.468	.062
11						.938	.254	.957	2.263	2.388	.031
12						1.261	.084	1.274	2.166	2.298	.025
13						1.371	.051	1.330	2.147	2.272	.025

Figure 14 Airfoil Surface Static Pressure Location

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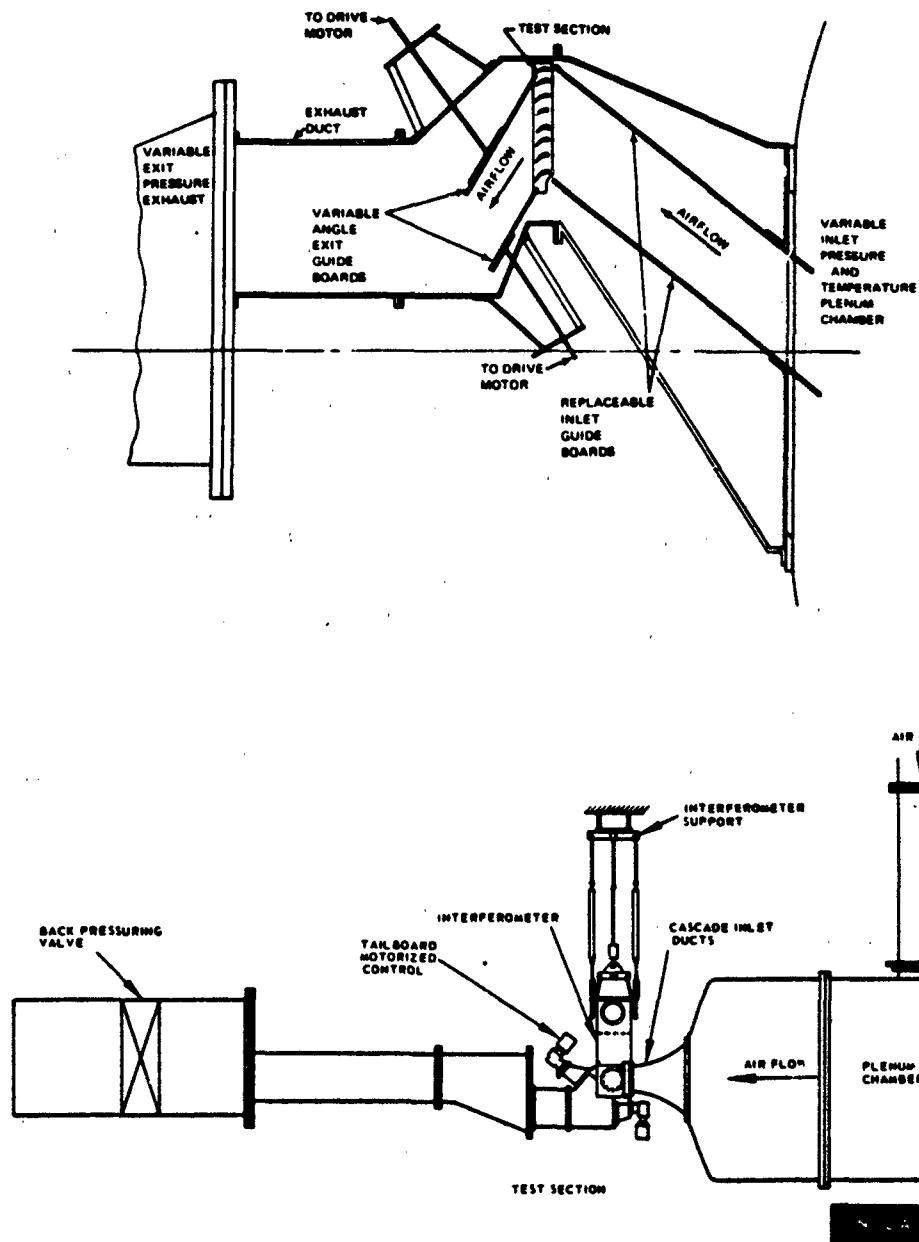


Figure 15 Schematic of Plane Cascade Test Rig

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SECTION IV

BASELINE AIRFOIL EVALUATION (TASK IIb)

1. RFP OBJECTIVE

- (U) Determine the design point performance of the baseline turbine airfoils and the need for corner boundary layer control.

2. TASK OBJECTIVE

- (U) Each of the baseline airfoil designs as determined by the Phase I portion of this Contract will be evaluated in an annular segment cascade, where the correct three-dimensional flow behavior will be closely reproduced. The purpose of these tests is to evaluate the average losses, so that by subtracting out the plane cascade two-dimensional losses, the net effects of secondary losses can be evaluated for comparison with the present design system secondary loss correlations. Location and severity of losses due to airfoil and/or corner boundary layer separation will be found if they occur. When separation does occur, simple flow visualization techniques will be employed in order to locate the beginning of the region of separation. This information will be required in the following Task where boundary layer control techniques will be applied, since the most effective techniques are those which are applied upstream of the existing point of separation. Furthermore, surface static pressure distributions will be measured on the airfoils in order to verify the aerodynamic concepts used in their design. These static pressure distributions will also assist in determining the location and extent of any regions of separation.

3. ANNULAR SEGMENT CASCADE AIRFOIL AND RIG DESIGN

- (U) The elevations of the first stage vane and blade as well as the second stage vane and blade which were determined as a result of the Phase I study are shown in Figure 16. The airfoil sections for the chosen medium reaction, normal solidity design were presented in the Phase I report, Reference 1. The fabrication coordinates for each of the sections indicated in Figure 16 are tabulated, in the Appendix, for the first vane in Tables V through XII, the first blade in Table XIII through XIX, the second vane in Table XX through XXVII, and for the second blade in Tables XXVIII through XXXIV. Additional airfoil information as airfoil angles, gaging distance, airfoil area, axial chord, uncovered turning are also tabulated. These airfoils have been fabricated for evaluation in the annular segment cascade rig.

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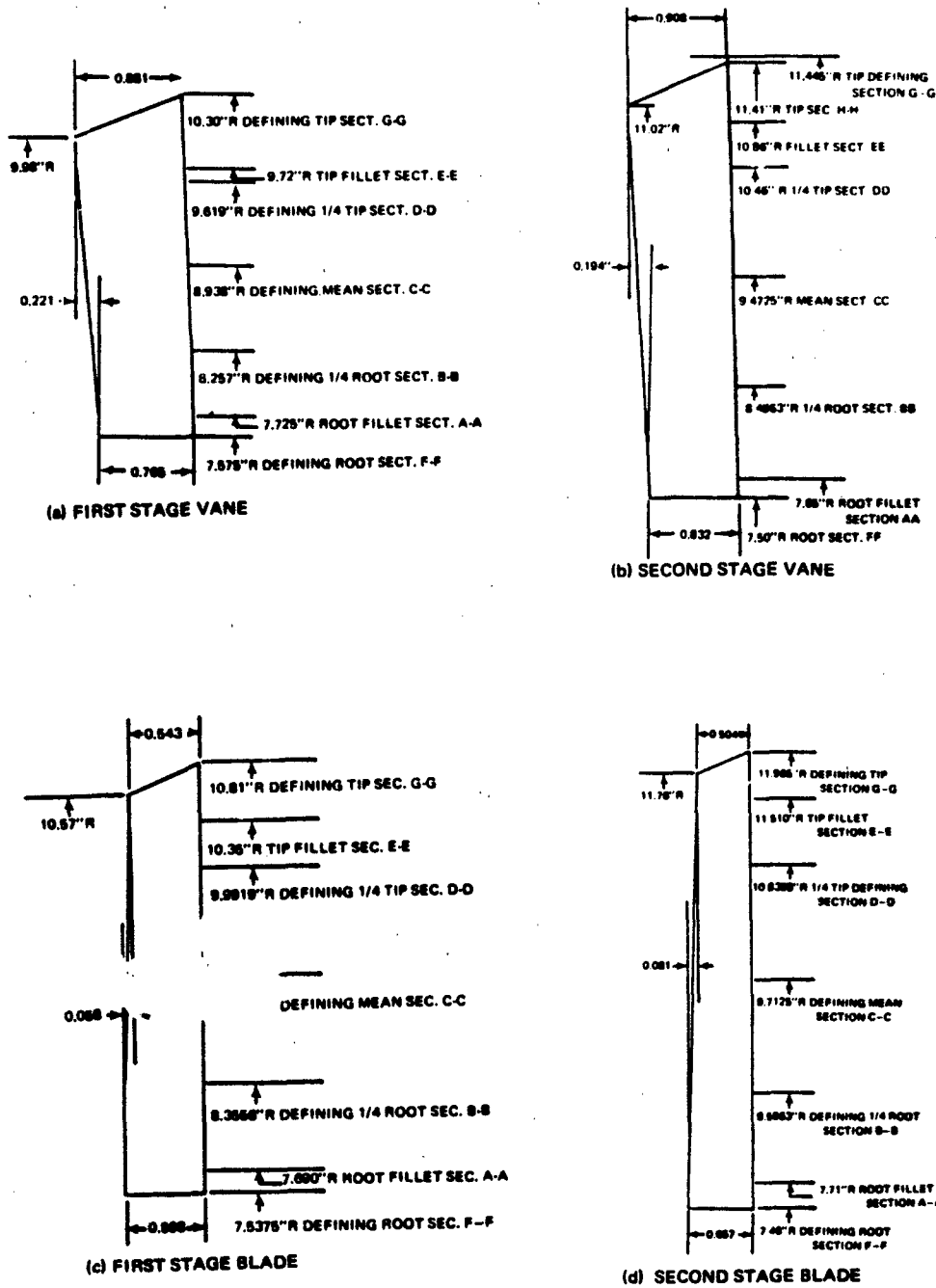


Figure 16 Turbine Test Airfoil Elevations

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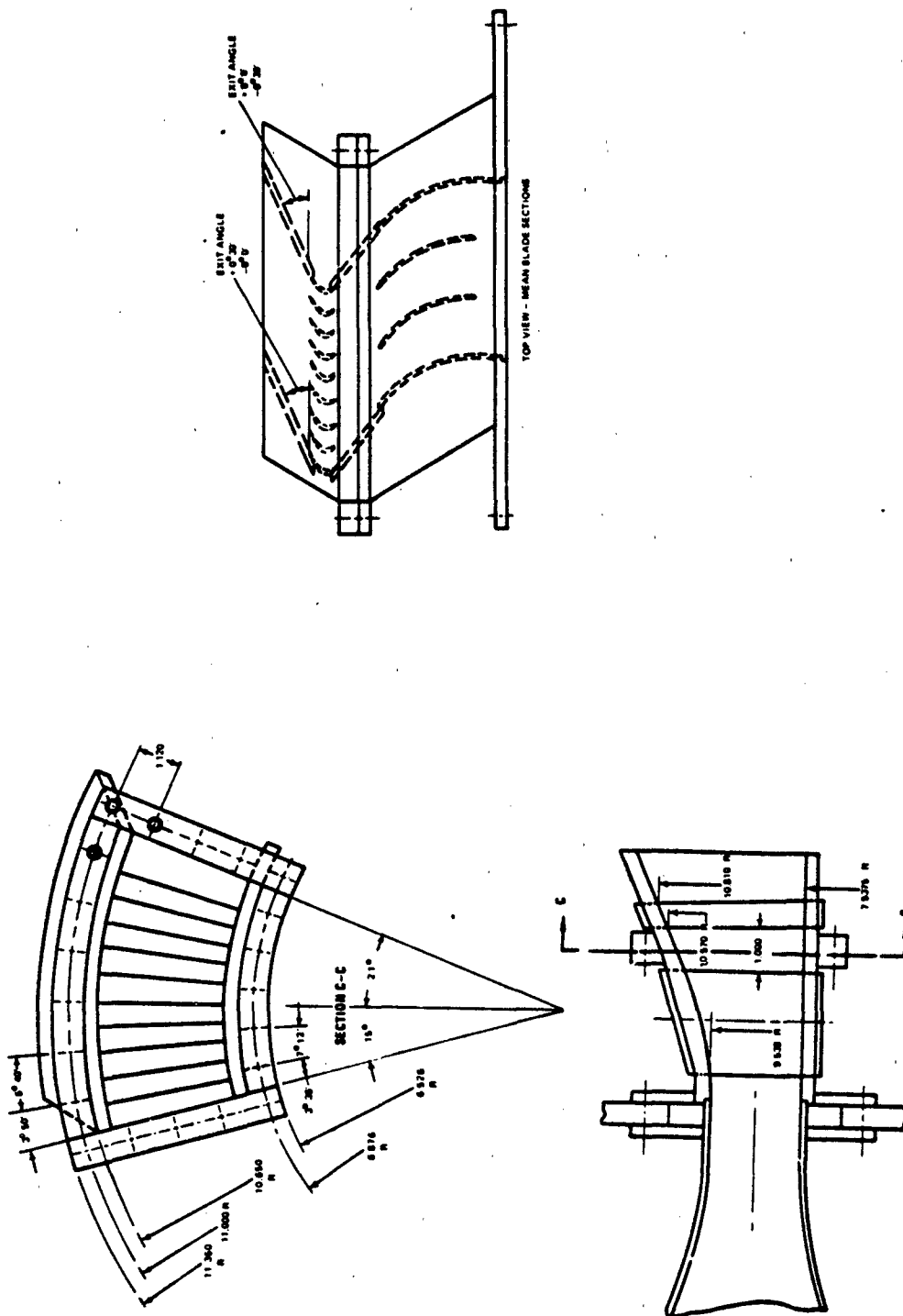
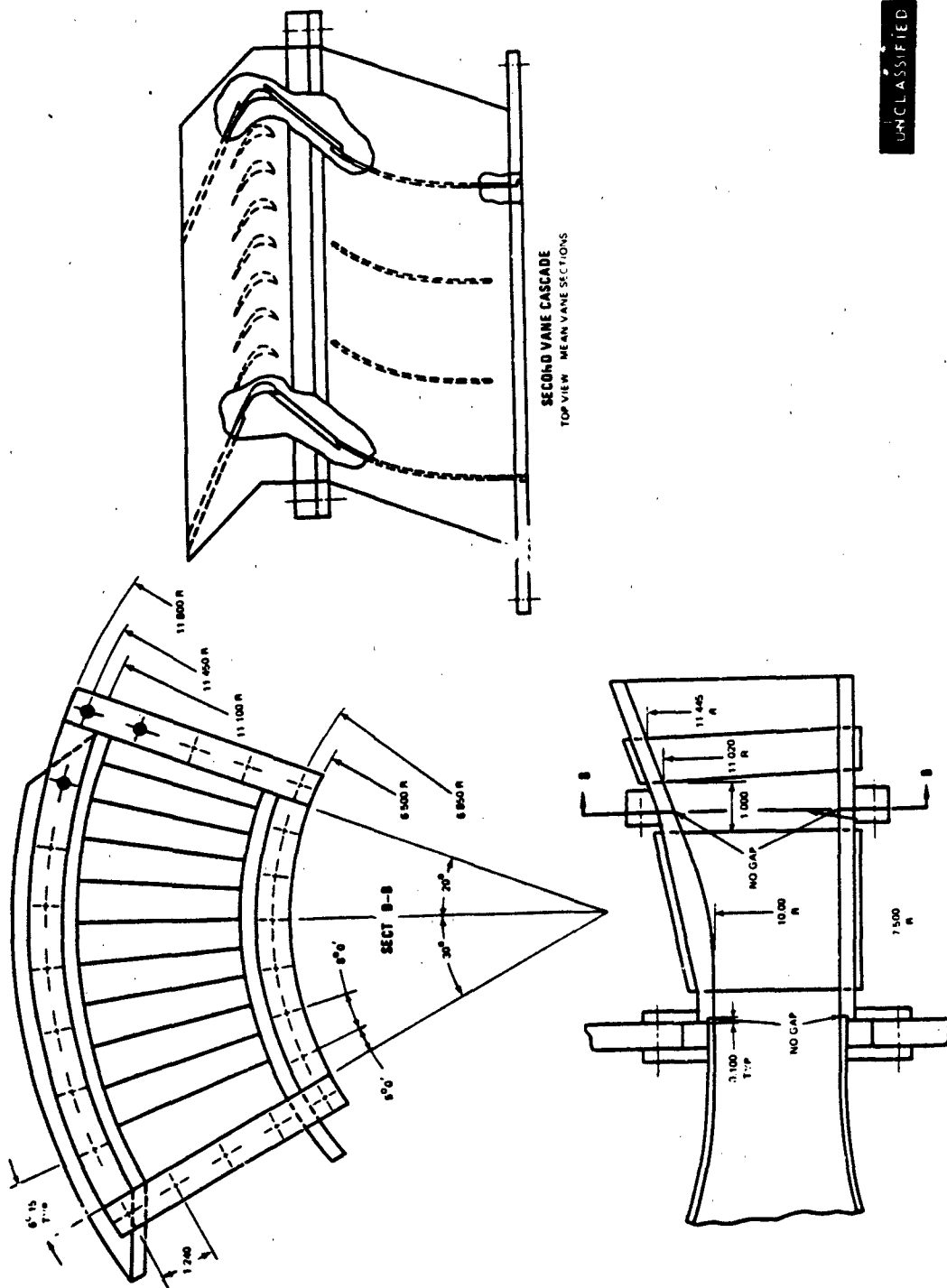


Figure 18 First Blade Cascade

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- (U) The test sections for each of the four airfoils to be evaluated in the annular segment cascade are shown in Figures 17 through 20. The inlet to each cascade consists of a bellmouth transition section followed by a turning vane which aligns the flow with its design angle. The turning vanes are followed by the test airfoils. In each case seven airfoils are used. These test airfoils then are followed by exit wall extensions.
- (U) The turning vane design was generated by applying the turbine streamline analysis program in order to provide proper inlet flow angles over the entire span of the test airfoils. Two long chord guide vanes are used in each cascade unit. The turning vane sector endwalls conform to the turning vane contours providing three uniform flow passages before the test cascades. The central three test airfoils will be between the turning vanes and entirely free of wake disturbances. The elevations, required turning vane exit angle and required test airfoil inlet angles are shown in Figure 21 through 32. The turning vane cross sections are shown in Figures 33 through 64, and the coordinates for these sections are shown in Tables XXXV through LXVI of the Appendix.
- (U) Analyses were also made to determine if potential problems of flow separation exist on the inside end wall extensions downstream of the test airfoils. If such separation occurs, it may trigger separation on the test airfoils and thus produce false indications of airfoil performance. The results of the analyses, fortunately, indicate that the end wall extension is sufficiently long to maintain a small enough pressure gradient to prevent separation.
- (U) Sufficient instrumentation is installed on the rig, on the flow path walls and airfoil surfaces to determine the loss coefficients and exit flow deviations for these cascades. Surface static pressure tap locations were installed on all four of the baseline airfoils as shown in Figure 65. The method of installing the taps is also indicated in this Figure. A total of 30 static taps were installed on each test channel. Static taps will be located at the midspan section as well as near the root and tip sections to obtain data in the end wall regions.
- (U) A single cone probe as shown in Figure 66 was chosen for the exit plane total and static pressure and angle traverse requirements. This probe will be positioned parallel to the midspan streamline. The resulting pitch angles with respect to the cascade end walls were analytically estimated. The probe was also calibrated to determine total and static pressure errors due to pitch angle over the test Mach number range. Based on these probe calibrations, corrections for pitch angle were added to the data reduction program.

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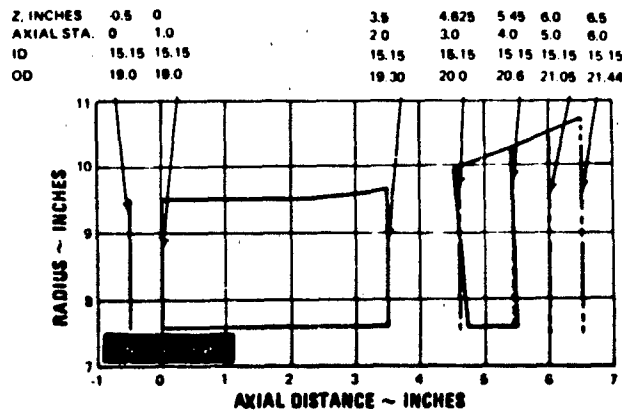


Figure 21 First Vane Cascade Elevation

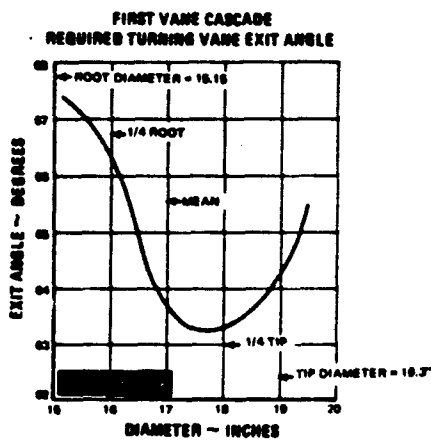


Figure 22 First Vane Cascade,
Required Turning Vane Exit Angle

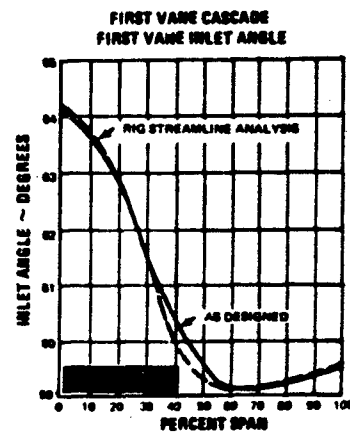


Figure 23 First Vane Cascade,
First Vane Inlet Angle

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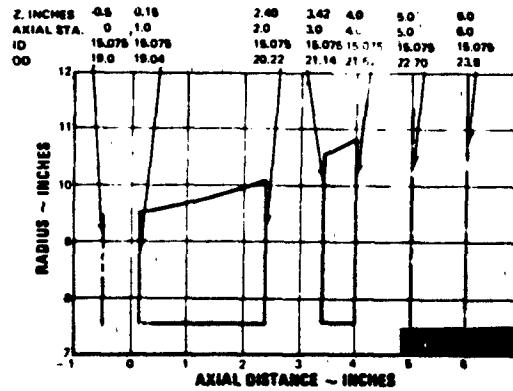


Figure 24 First Blade Cascade Elevation

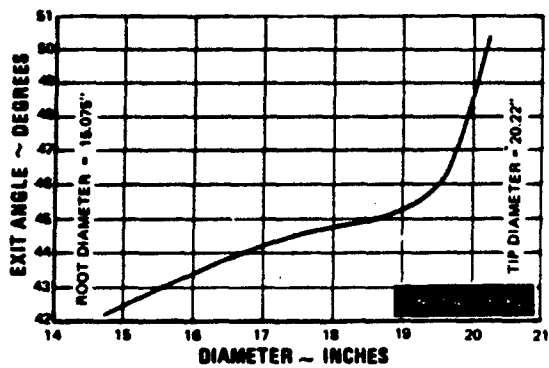


Figure 25 First Blade Cascade Required Turning Vane Exit Angle

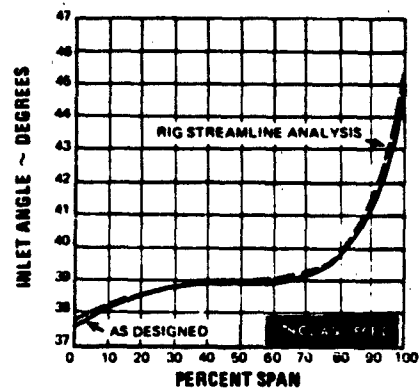


Figure 26 First Blade Cascade First Blade Inlet Angle

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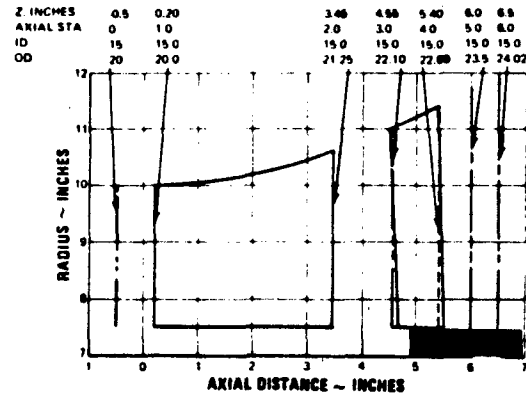


Figure 27 Second Vane Cascade Elevation

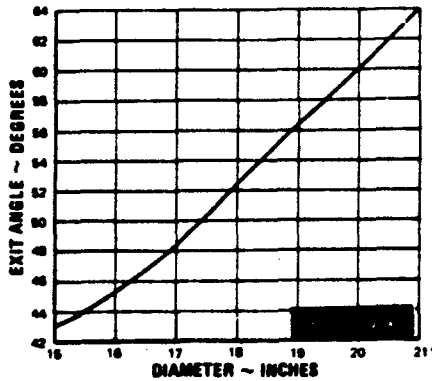


Figure 28 Second Vane Cascade Required Turning Vane Exit Angle

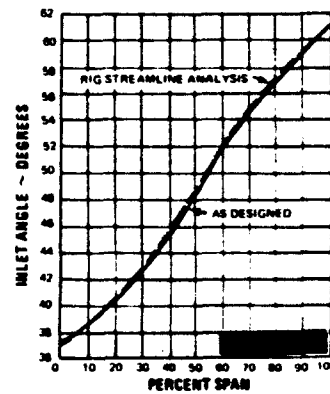


Figure 29 Second Vane Cascade, Second Vane Inlet Angle

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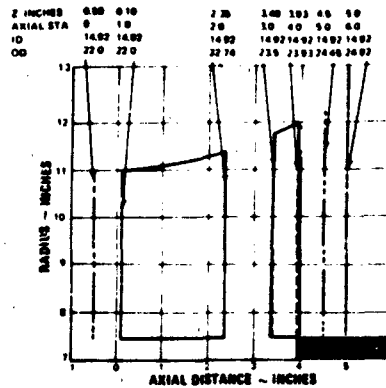


Figure 30 Second Blade Cascade Elevation

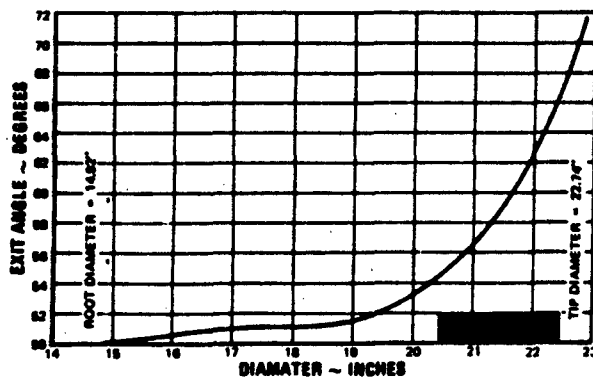


Figure 31 Second Blade Cascade Required Turning Vane Exit Angle

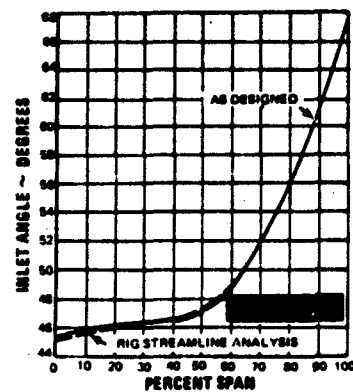


Figure 32 Second Blade Cascade, Second Blade Inlet Angle

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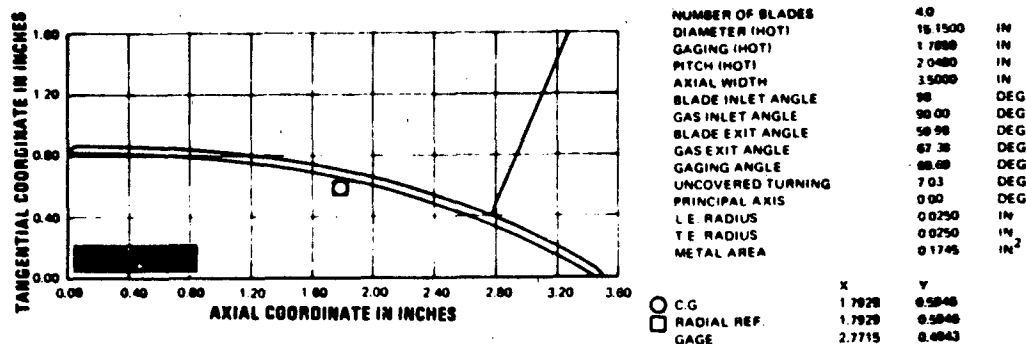


Figure 33 First Vane Cascade Turning Vane Root Section

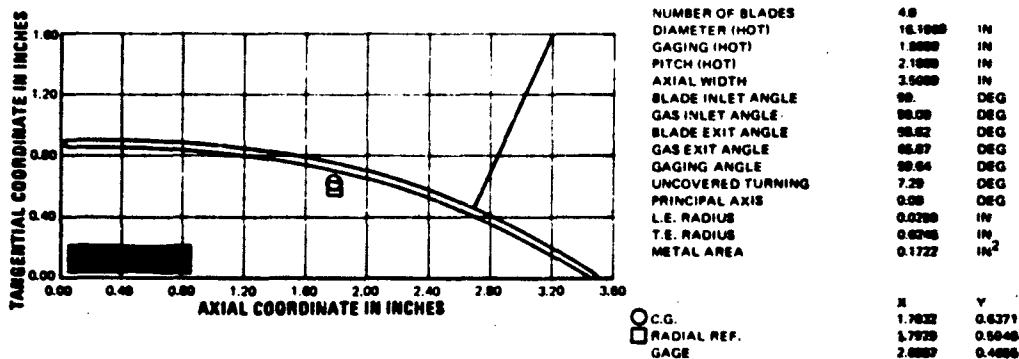


Figure 34 First Vane Cascade Turning Vane 1/4R Section

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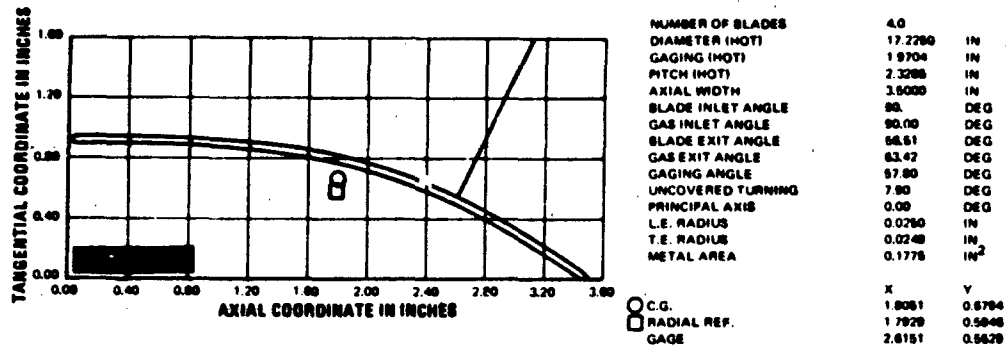


Figure 35 First Vane Cascade Turning Vane Mean Section

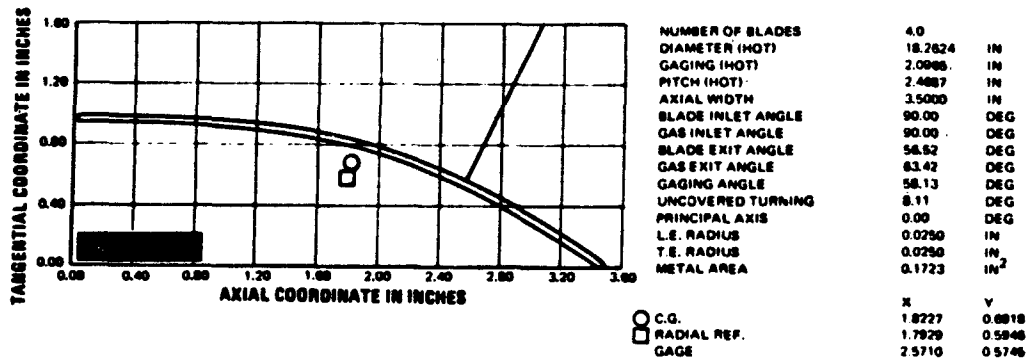


Figure 36 First Vane Cascade Turning Vane 1/4T Section

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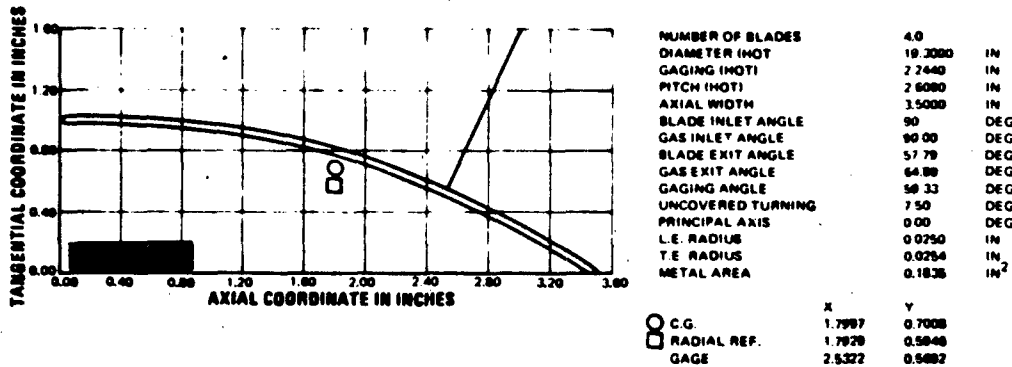


Figure 37 First Vane Cascade Turning Vane Tip Section

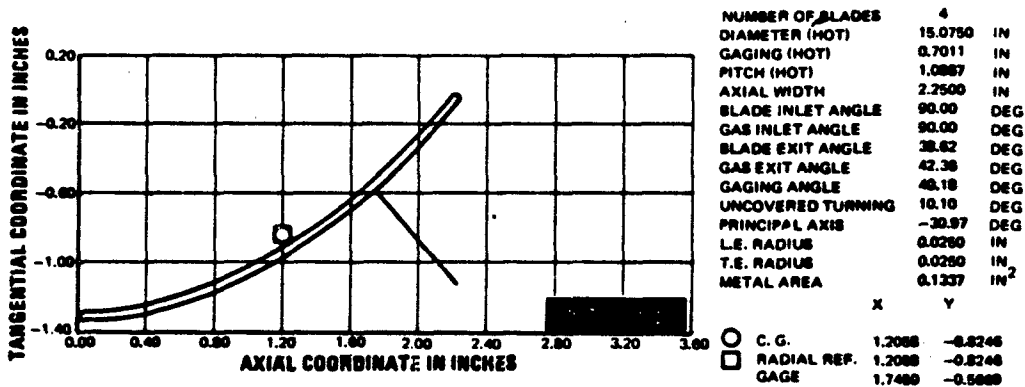


Figure 38 First Blade Cascade Turning Vane Root Section

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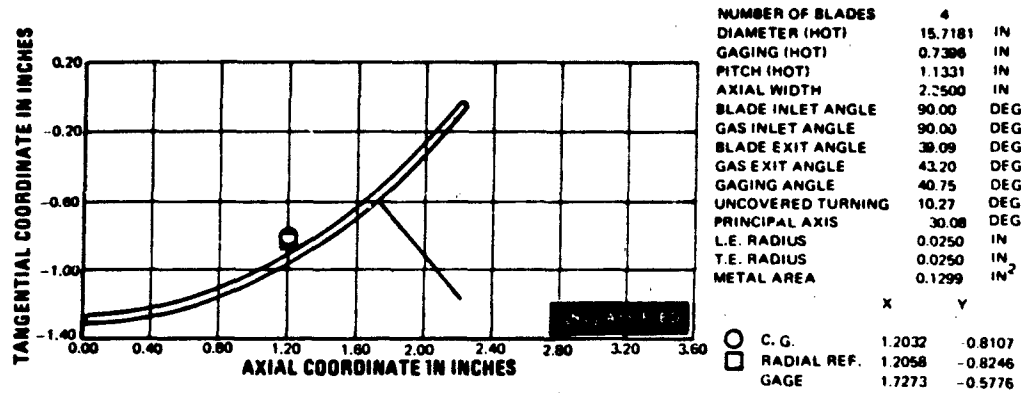


Figure 39 First Blade Cascade Turning Vane 1/8R Section

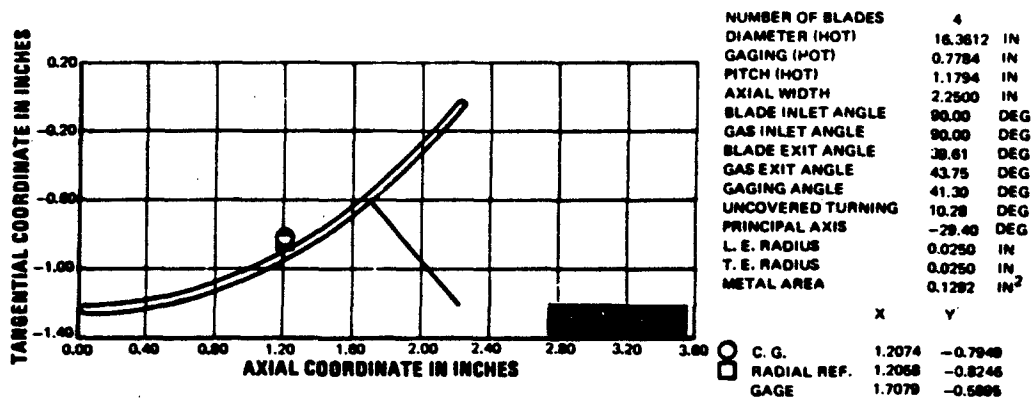


Figure 40 First Blade Cascade Turning Vane 1/4R Section

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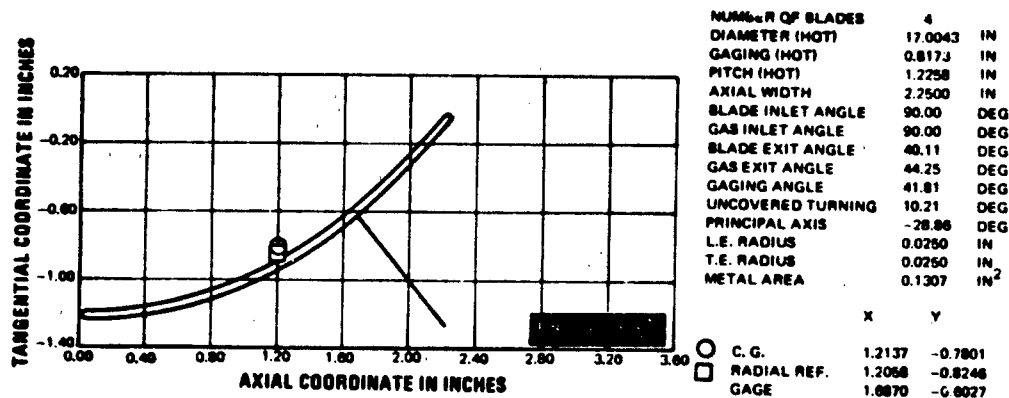


Figure 41 First Blade Cascade Turning Vane 3/8R Section

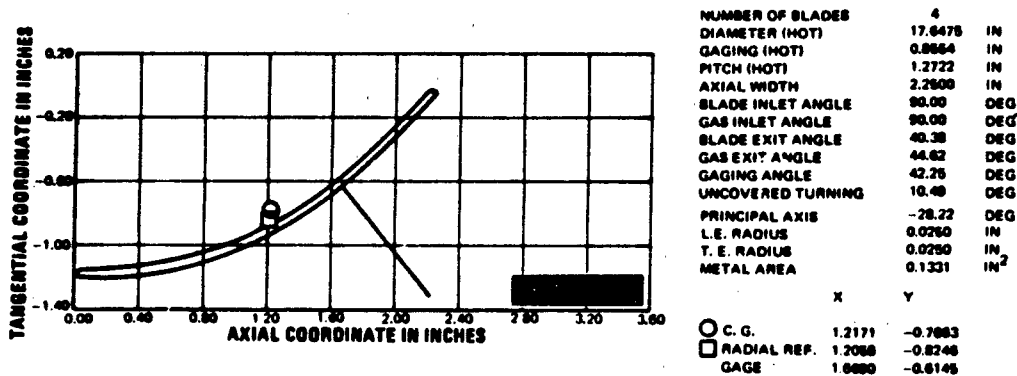


Figure 42 First Blade Cascade Turning Vane Mean Section

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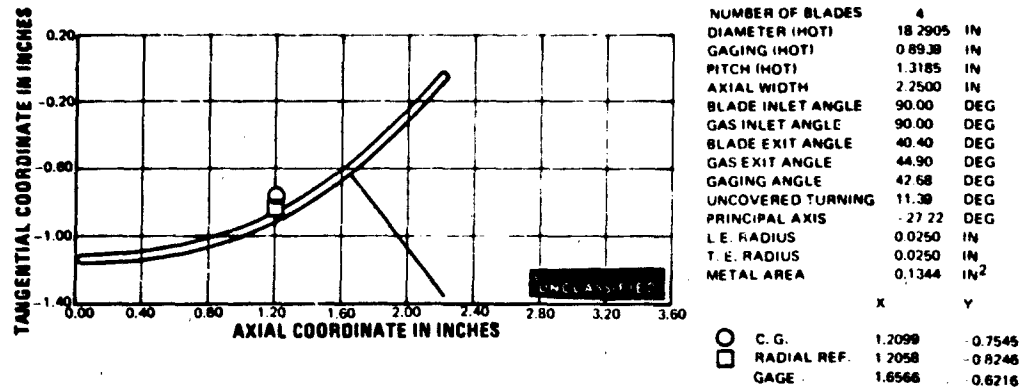


Figure 43 First Blade Cascade Turning Vane 1/8T Section

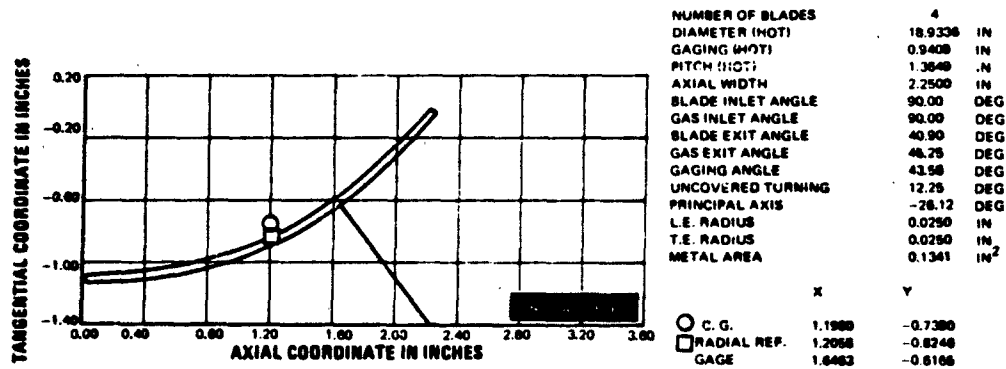


Figure 44 First Blade Cascade Turning Vane 1/4T Section

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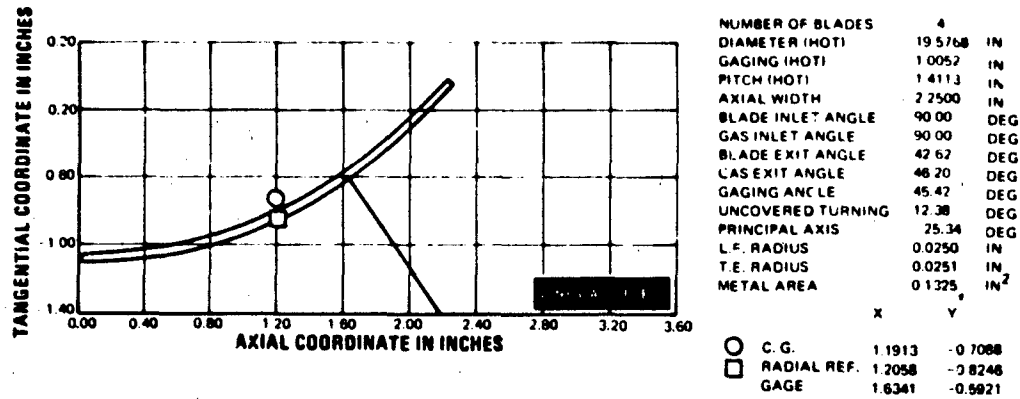


Figure 45 First Blade Cascade Turning Vane 3/8T Section

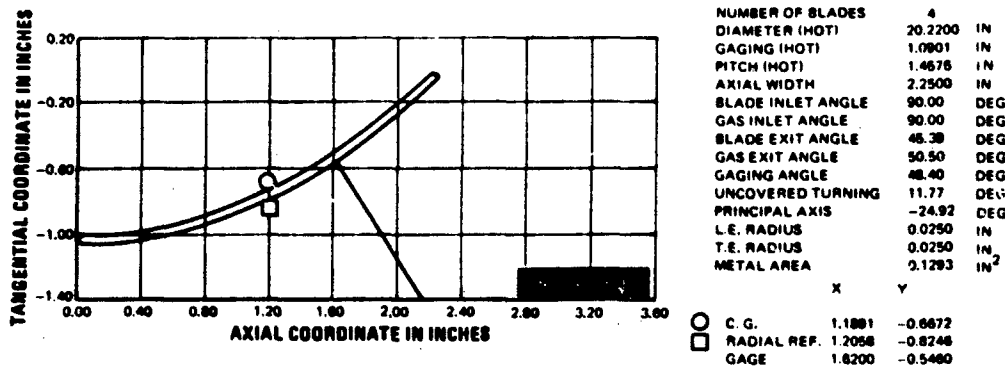


Figure 46 First Blade Cascade Turning Vane Tip Section

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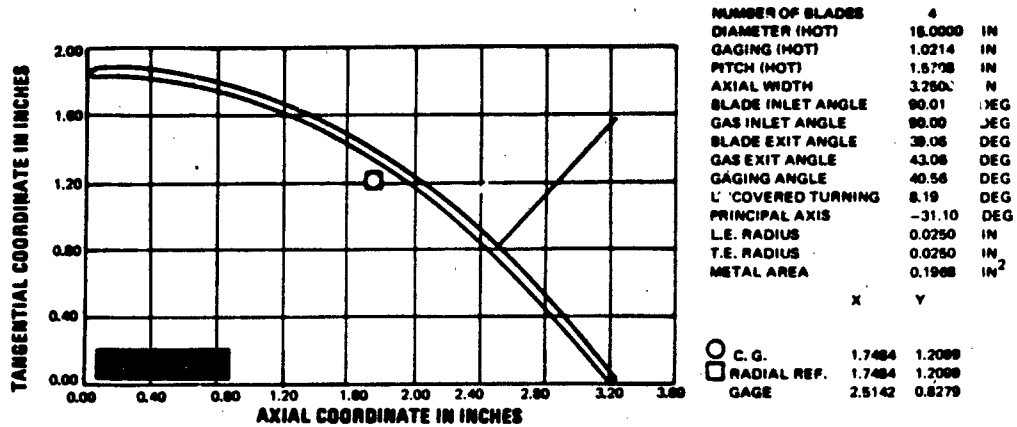


Figure 47 Second Vane Cascade Turning Vane Root Section

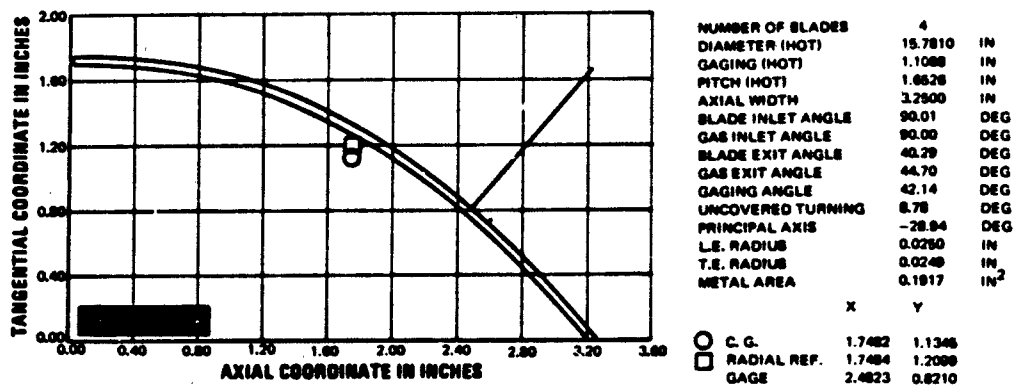


Figure 48 Second Vane Cascade Turning Vane 1/8R Section

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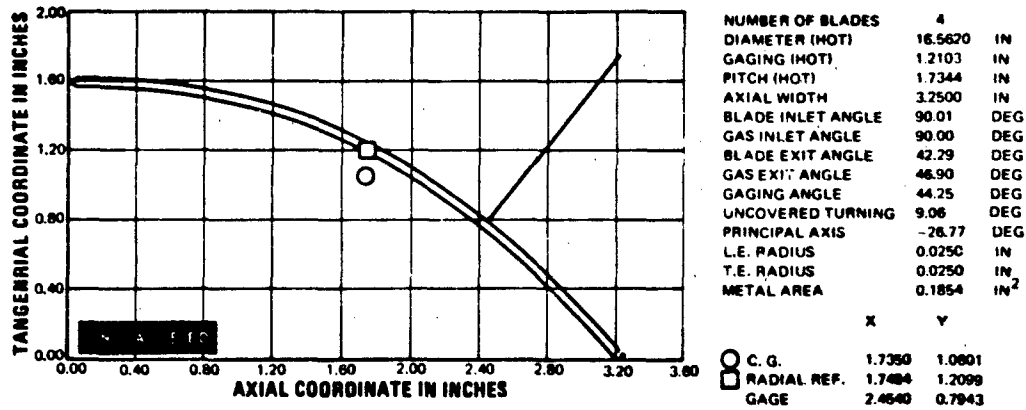


Figure 49 Second Vane Cascade Turning Vane 1/4R Section

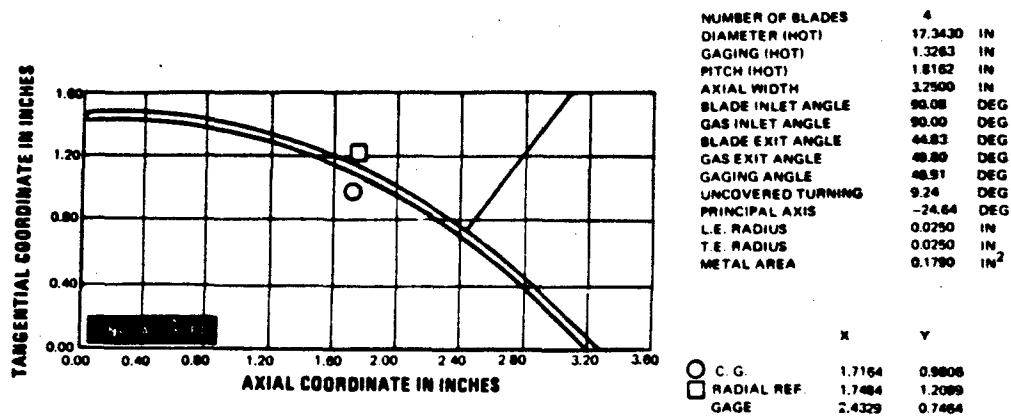


Figure 50 Second Vane Cascade Turning Vane 3/8R Section

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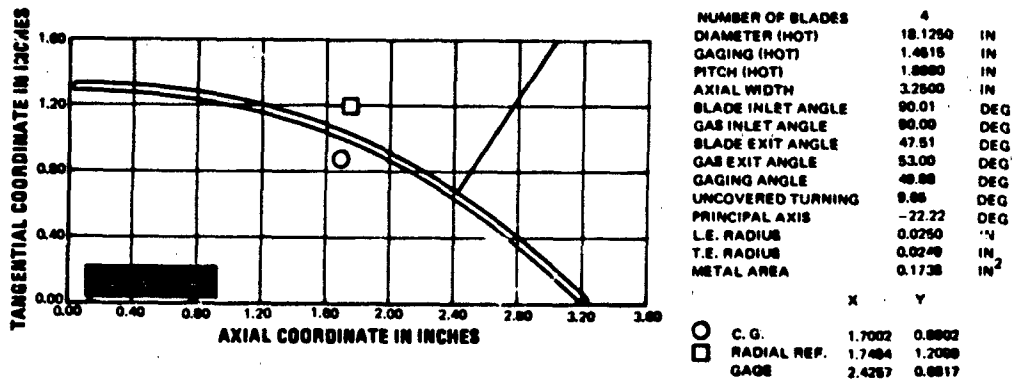


Figure 51 Second Vane Cascade Turning Vane Mean Section

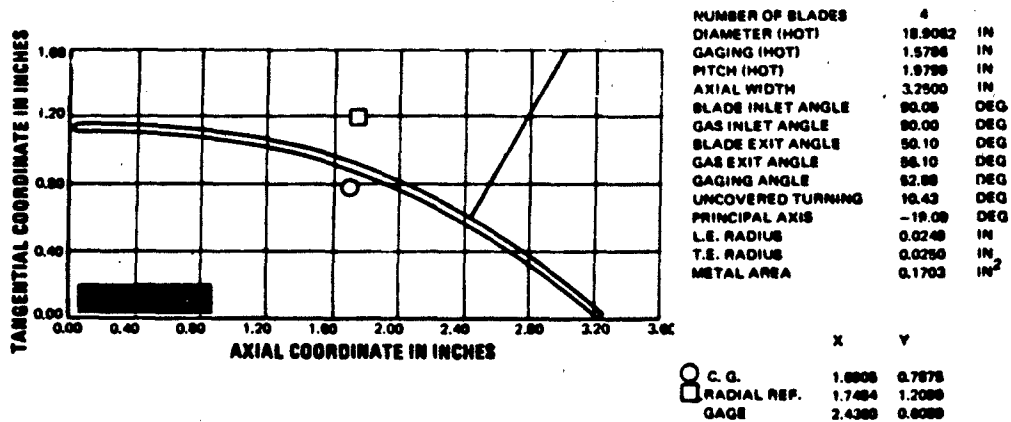


Figure 52 Second Vane Cascade Turning Vane 1/8T Section

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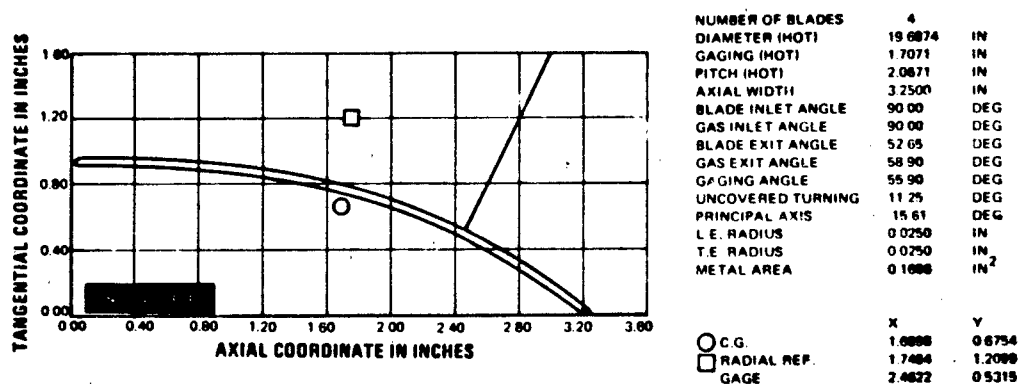


Figure 53 Second Vane Cascade Turning Vane 1/4T Section

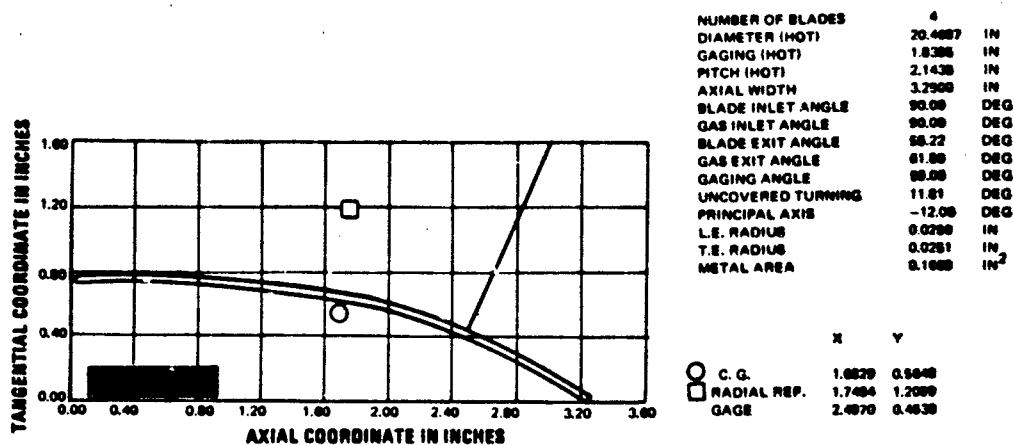


Figure 54 Second Vane Cascade Turning Vane 3/8T Section

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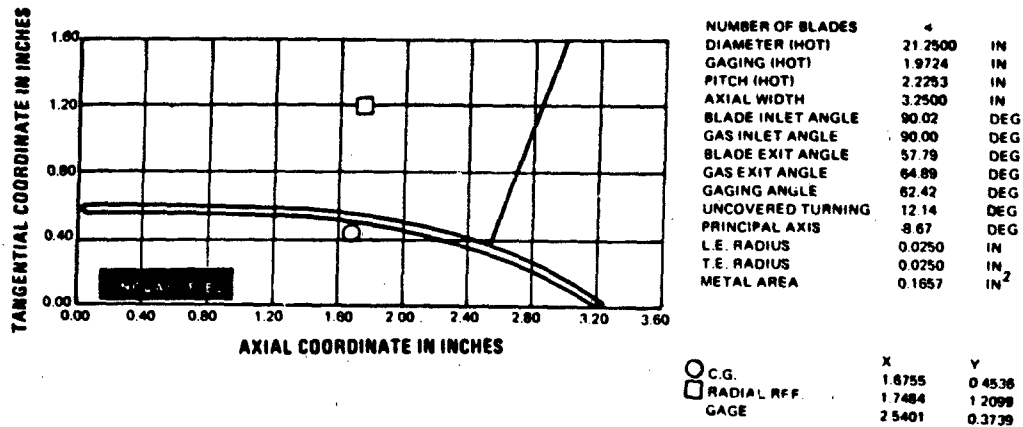


Figure 55 Second Vane Cascade Turning Vane Tip Section

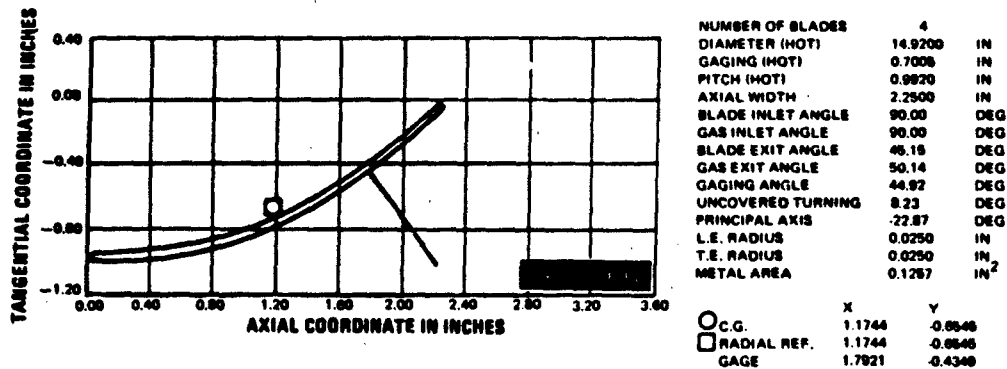


Figure 56 Second Blade Cascade Turning Vane Root Section

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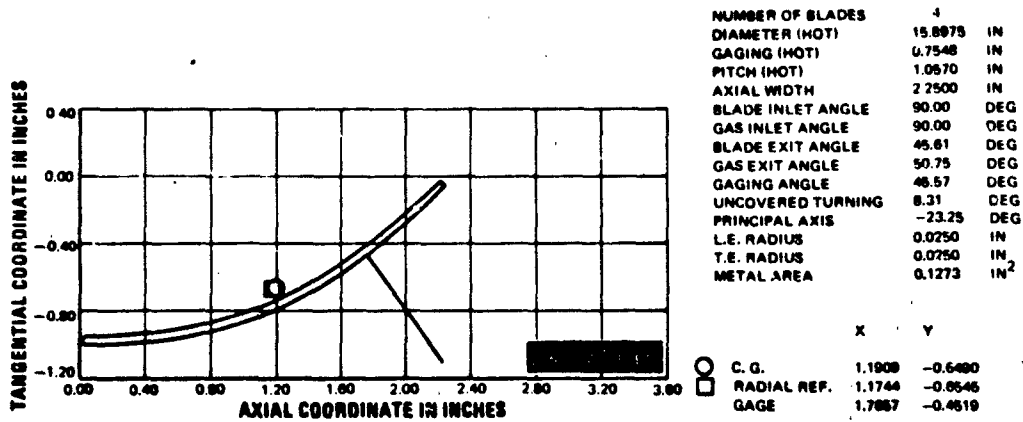


Figure 57 Second Blade Cascade Turning Vane 1/8R Section

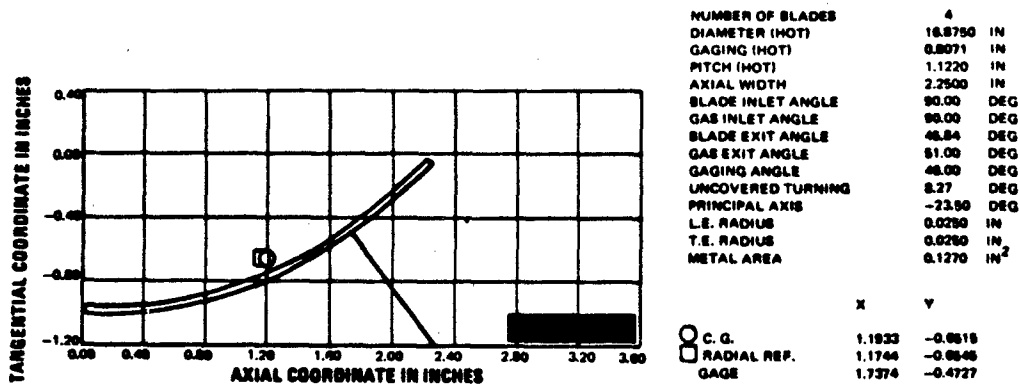


Figure 58 Second Blade Cascade Turning Vane 1/4R Section

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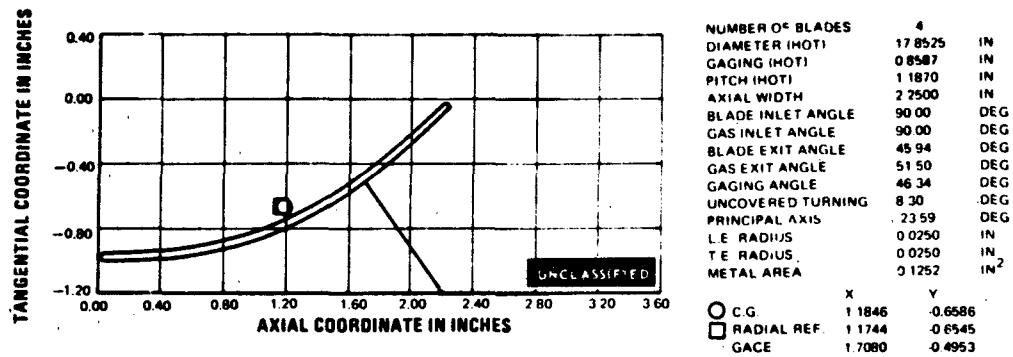


Figure 59 Second Blade Cascade Turning Vane 3/8R Section

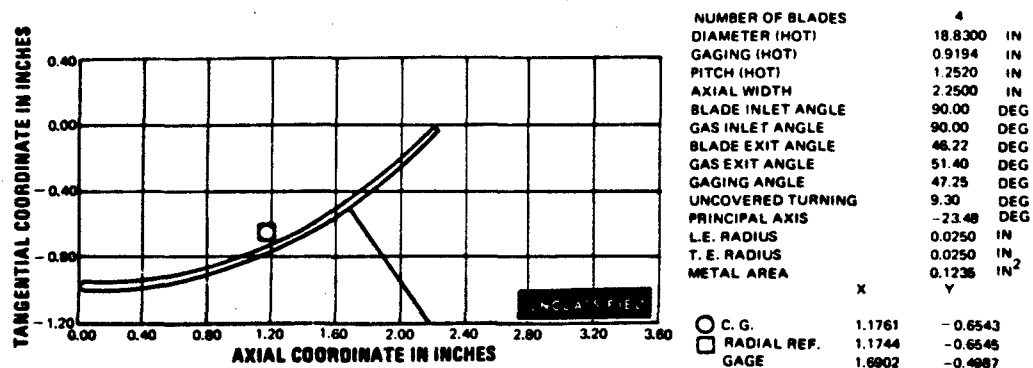


Figure 60 Second Blade Cascade Turning Vane Mean Section

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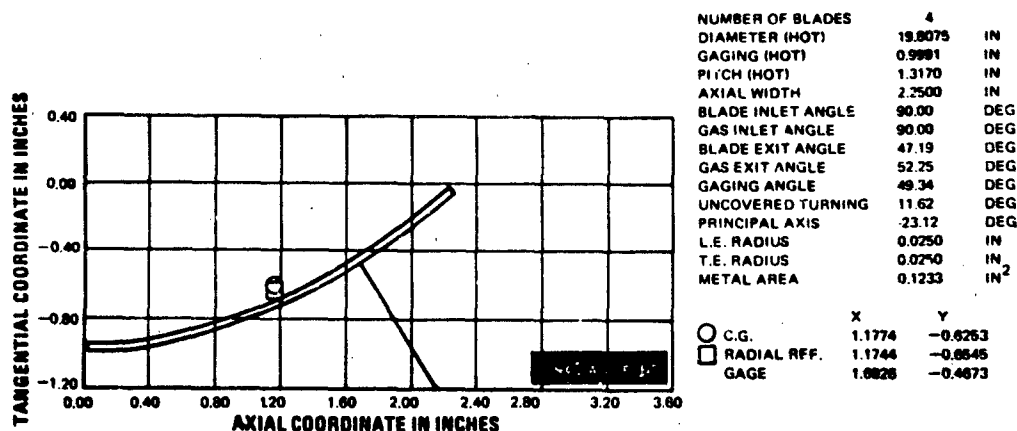


Figure 61 Second Blade Cascade Turning Vane 1/8T Section

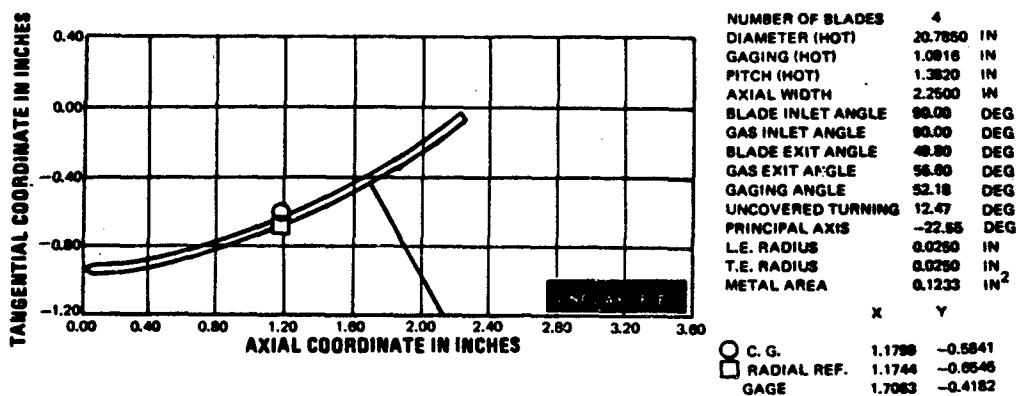


Figure 62 Second Blade Cascade Turning Vane 1/4T Section

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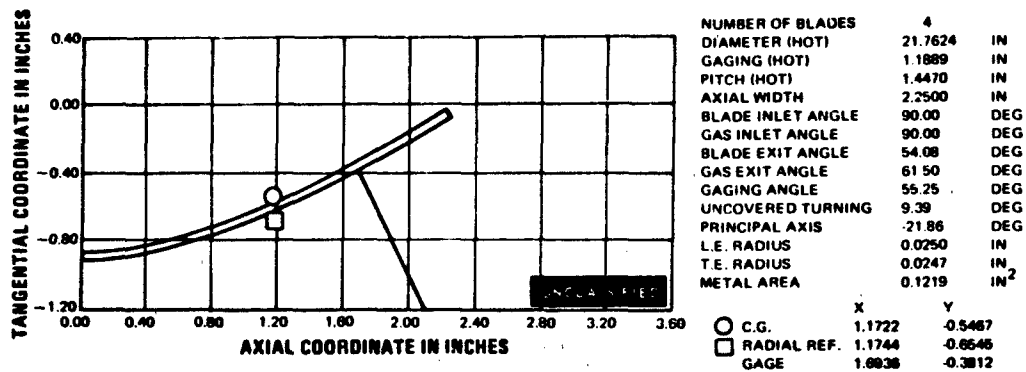


Figure 63 Second Blade Cascade Turning Vane 3/8T Section

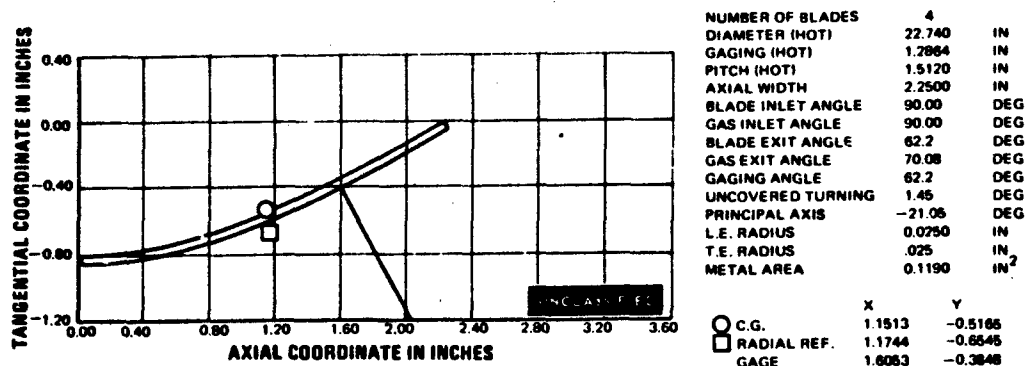
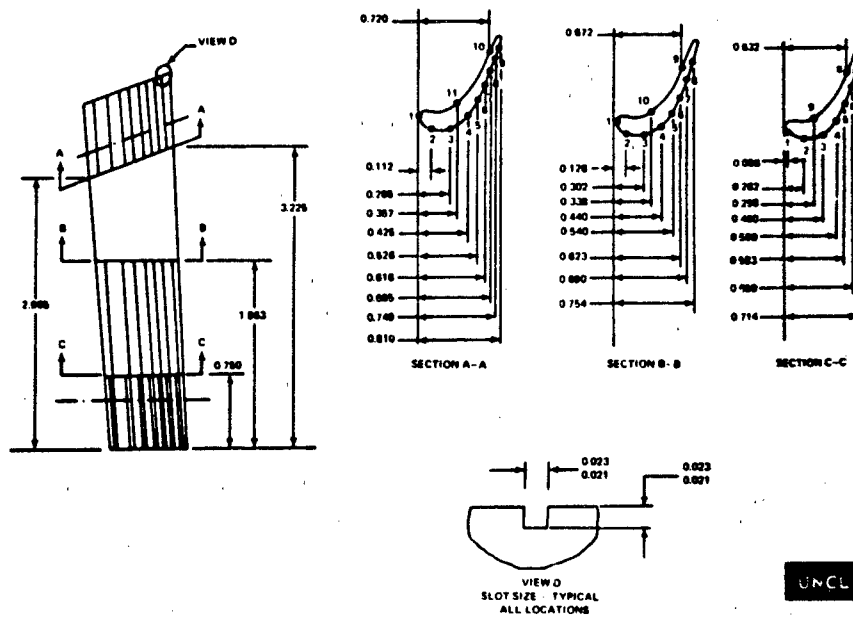


Figure 64 Second Blade Cascade Turning Vane Tip Section

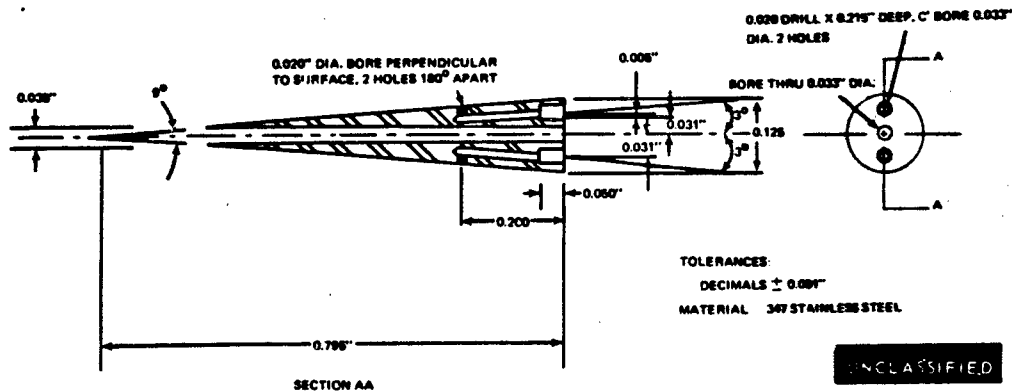
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Figure 65 Airfoil Static Pressure Tap Locations-First Stage Vane



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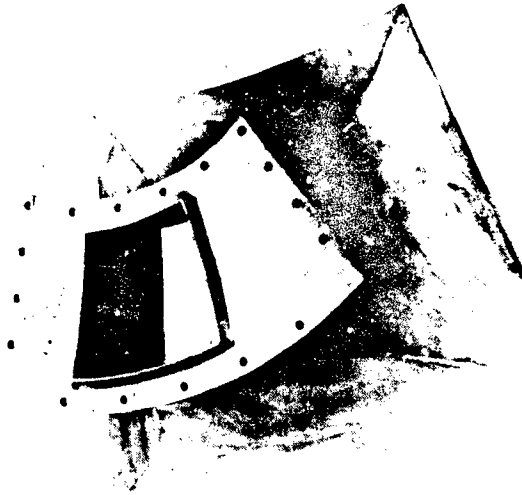
Figure 66 Traverse Probe Head, Annular Cascade

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- (U) A traversing probe was also installed just upstream of the test airfoils in order to measure the losses due to the turning vane, and to measure the actual inlet flow angle seen by the test airfoils. Turning vane losses will be accounted for in the data reduction program used to calculate the test airfoil performance.
- (U) The completed annular segment cascade test sections have been received from fabricators. One of these is shown in Figure 67 to 72. The first vane cascade was installed in the test rig (Figures 73 and 74) and checkout runs have been completed.

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Figure 67 Second Stage Blade Annular Segment Cascade, Inlet Bellmouth



Figure 68 Second Stage Blade Annular Segment Cascade, Turning Vane Assembly

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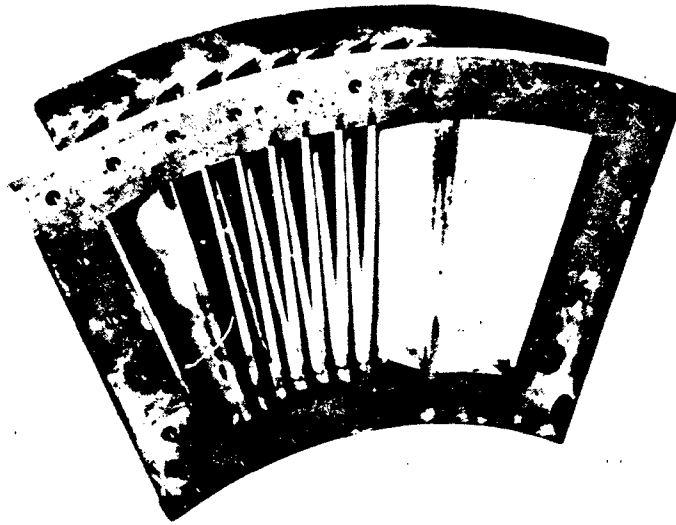


Figure 69 Second Stage Blade Annular Segment Cascade, Test Airfoil Assembly



Figure 70 Second Stage Blade Annular Segment Cascade, Inlet View of Assembled Rig

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Figure 71 Second Stage Blade Annular Segment Cascade, Top View of Assembled Rig



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Figure 72 Second Stage Blade Annular Segment Cascade, Side View of Assembled Rig

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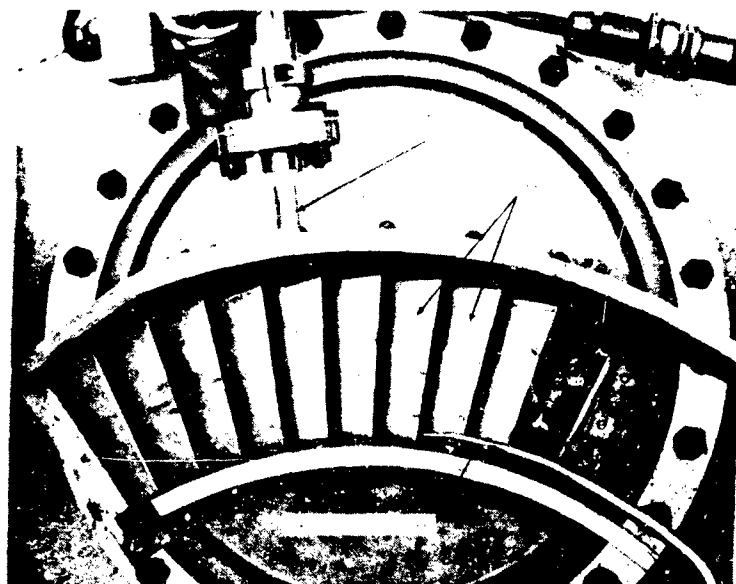
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Figure 73 Installation of First Stage Vane in Annular Segment Cascade Rig, Overall View



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Figure 74 Installation of First Stage Vane in Annular Segment Cascade Rig, Close-up View

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SECTION V

PRELIMINARY DESIGN MANUAL PREPARATION (TASK IIe)

1. RFP OBJECTIVE

- (U) Prepare the preliminary draft of the Turbine Design Procedure Manual.

2. TASK OBJECTIVE

- (U) The purpose of this task is to prepare and deliver a Turbine Design Procedure Manual. This manual will contain, for each computer program used to design the contract turbine, the following information: a flow diagram; a listing for all input and output items and their definitions; a list of definitions for each term used in the computer code; a writeup of the pertinent engineering equations; listing of the computer code in Fortran IV; a copy of the computer program deck in Fortran IV; any necessary test cases for deck checkout.

3. STATUS

- (U) Work is in progress on the following computer programs:
 - (a) Turbine Mean Line Design Program
 - (b) Turbine Stage Off Design Program
 - (c) Turbine Streamline Analysis Program
 - (d) Airfoil Pressure Distribution Program
 - (e) Airfoil Boundary Layer Program
 - (f) Turbine Airfoil Design and Section Properties Program
 - (g) Airfoil Curved Line Fairing Program
 - (h) Airfoil Straight Line Fairing Program

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TABLE V
VANE 1 NORMAL SOLIDITY

Section AA	AT R = 7.72500				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.01374	.66617	.65336	.61682	.65336
.01	-.00601	.67382	.67367	.61837	.63306
.02	.00172	.68115		.61984	.62681
.03	.00945	.68816		.62122	.62373
.04	.01718	.69486		.62252	.62283
.05	.02491	.70123		.62373	
.10	.06356	.72832		.62831	
.15	.10221	.74744		.63014	
.20	.14085	.75860		.62873	
.25	.17950	.76184		.62355	
.30	.21815	.75725		.61400	
.35	.25680	.74493		.59951	
.40	.29545	.72500		.57957	
.45	.33410	.69763		.55376	
.50	.37275	.66297		.52191	
.55	.41140	.62123		.48402	
.60	.45005	.57260		.44035	
.65	.48869	.51729		.39132	
.70	.52734	.45561		.33746	
.75	.56599	.38808		.27935	
.80	.60464	.31538		.21752	
.85	.64329	.23817		.15249	
.90	.68194	.15713		.08468	
.95	.72059	.07282		.01446	
.98	.74378	.02087		-.02870	-.02538
.99	.75151	.00335		-.04325	-.02642
1.00	.75924	-.01427	-.01643	-.05787	-.01643
LE Center	(.01679,	.65336)	R = .03053		
TE Center	(.74892,	-.01643)	R = .01032		
Center of Gravity	(.35251,	.53249)			
Radial Reference	(.36300,	.53208)			
Gaging =	.34537				
Nose Point	(-.00961,	.63802)			
Tail Point	(.75339,	-.02573)			
LE Tangency Points	Top	(-.00422,	.67552)	Bottom (.02150,	.62320)
TE Tangency Points	Top	(.75837,	-.01229)	Bottom (.73982,	-.02129)
Inlet Angle =	63.82050				
Exit Angle =	25.90222				
No. of Blades =	62				
Pitch =	.78286				
Tolerance =	-.00000				
Gaging =	.34537				
Uncovered Turning =	12.05888				
Gaging Angle =	26.17782				
Area =	.08706				
Axial Chord =	.77298				

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TABLE VI

VANE 1 NORMAL SOLIDITY

Section BB	AT R = 8.25650				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.06249	.66860	.65560	.61532	.65560
.01	-.05448	.67705	.67697	.61721	.63423
.02	-.04646	.68518		.61903	.62758
.03	-.03845	.69299		.62076	.62422
.04	-.03044	.70048		.62240	.62310
.05	-.02243	.70764		.62396	
.10	.01764	.73850		.63031	
.15	.05770	.76099		.63390	
.20	.09776	.77496		.63418	
.25	.13782	.78029		.63051	
.30	.17789	.77691		.62217	
.35	.21795	.76483		.60839	
.40	.25801	.74410		.58846	
.45	.29807	.71481		.56175	
.50	.33814	.67712		.52790	
.55	.37820	.63121		.48682	
.60	.41826	.57732		.43875	
.65	.45832	.51569		.38419	
.70	.49839	.44676		.32379	
.75	.53845	.37130		.25828	
.80	.57851	.29026		.18837	
.85	.61857	.20460		.11469	
.90	.65864	.11516		.03781	
.95	.69870	.02263		-.04184	
.98	.72274	-.03416		-.09080	-.08500
.99	.73075	-.05328		-.10730	-.08555
1.00	.73876	-.07248	-.07474	-.12389	-.07474
LE Center	(-.02999,	.65560)	R = .03250		
TE Center	(.72747,	-.07474)	R = .01130		
Center of Gravity	(.31526,	.53317)			
Radial Reference	(.36300,	.53208)			
Gaging =	.34823				
Nose Point	(-.05745,	.63822)			
Tail Point	(.73209,	-.08505)			
LE Tangency Points	Top	(-.05314,	.67841)	Bottom (-.02379,	.62370)
TE Tangency Points	Top	(.73789,	-.07039)	Bottom (.71732,	-.07970)
Inlet Angle =	61.78913				
Exit Angle =	24.33544				
No. of Blades =	62				
Pitch =	.83673				
Tolerance =	-.00000				
Gaging =	.34823				
Uncovered Turning =	11.20821				
Gaging Angle =	24.59364				
Area =	.09610				
Axial Chord =	.80125				

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TABLE VII
VANE 1 NORMAL SOLIDITY

Section CC	AT R = 8.93800				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.12500	.68689	.67373	.62805	.67373
.01	-.11662	.69648	.69646	.63052	.65100
.02	-.10825	.70574		.63289	.64384
.03	-.09987	.71466		.63516	.64012
.04	-.09150	.72325		.63732	.63873
.05	-.08312	.73149		.63937	.63937
.10	-.04125	.76748		.64782	
.15	.00063	.79442		.65288	
.20	.04250	.81196		.65394	
.25	.08438	.81978		.65029	
.30	.12625	.81764		.64118	
.35	.16813	.80544		.62585	
.40	.21000	.78311		.60354	
.45	.25188	.75075		.57364	
.50	.29375	.70849		.53576	
.55	.33563	.65661		.48977	
.60	.37750	.59541		.43583	
.65	.41938	.52527		.37439	
.70	.46125	.44675		.30606	
.75	.50313	.36072		.23157	
.80	.54500	.26824		.15165	
.85	.58688	.17038		.06700	
.90	.62875	.06805		-.02179	
.95	.67063	-.03800		-.11419	
.98	.69575	-.10318		-.17119	-.16133
.99	.70413	-.12514		-.19043	-.16134
1.00	.71250	-.14721	-.14951	-.20980	-.14951
LE Center	(-.08996,	.67373)	R = .03503		
TE Center	(.69996,	-.14951)	R = .01255		
Center of Gravity	(.27240,	.53977)			
Radial Reference	(.36300,	.53208)			
Gaging =	.34627				
Nose Point	(-.11858,	.65352)			
Tail Point	(.70467,	-.16114)			
LE Tangency Points	Top	(-.11594,	.69723)	Bottom (-.08303,	.63939)
TE Tangency Points	Top	(.71169,	-.14506)	Bottom (.68846,	-.15454)
Inlet Angle =	60.36023				
Exit Angle =	22.21311				
No. of Blades =	62				
Pitch =	.90579				
Tolerance =	-.00000				
Gaging =	.34627				
Uncovered Turning =	10.49118				
Gaging Angle =	22.47510				
Area =	.11466				
Axial Chord =	.83750				

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TABLE VIII

VANE 1 NORMAL SOLIDITY

Section DD	AT R = 9.61900				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.18749	.72178	.70763	.65812	.70763
.01	-.17875	.73176	.73172	.66091	.68354
.02	-.17001	.74141		.66354	.67588
.03	-.16127	.75071		.66603	.67181
.04	-.15254	.75967		.66836	.67014
.05	-.14380	.76829		.67054	.67055
.10	-.10011	.80601		.67891	
.15	-.05642	.83446		.68272	
.20	-.01274	.85319		.68145	
.25	.03095	.86182		.67451	
.30	.07464	.85999		.66134	
.35	.11833	.84746		.64138	
.40	.16201	.82404		.61414	
.45	.20570	.78965		.57922	
.50	.24939	.74433		.53632	
.55	.29308	.68819		.48532	
.60	.33676	.62144		.42623	
.65	.38045	.54438		.35923	
.70	.42414	.45742		.28465	
.75	.46783	.36131		.20288	
.80	.51151	.25703		.11439	
.85	.55520	.14565		.01967	
.90	.59889	.02817		-.08081	
.95	.64258	-.09459		-.18662	
.98	.66879	-.17049		-.25250	-.23752
.99	.67753	-.19614		-.27485	-.23706
1.00	.68626	-.22195	-.22423	-.29738	-.22423
LE Center	(-.14991,	.70763)	R = .03758		
TE Center	(.67247,	-.22423)	R = .01380		
Center of Gravity	(.23699,	.54262)			
Radial Reference	(.36300,	.53208)			
Gaging =	.34133				
Nose Point	(-.18055,	.68587)			
Tail Point	(.67717,	-.23720)			
LE Tangency Points	Top	(-.17776,	.73286)	Bottom (-.14284,	.67072)
TE Tangency Points	Top	(.68554,	-.21980)	Bottom (.65965,	-.22933)
Inlet Angle =	60.66503				
Exit Angle =	20.19620				
No. of Blades -	62				
Pitch =	.97481				
Tolerance =	-.00000				
Gaging =	.34133				
Uncovered Turning =	10.58125				
Gaging Angle =	20.49633				
Area =	.13955				
Axial Chord	.87375				

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TABLE IX
VANE 1 NORMAL SOLIDITY

Section EE	AT R = 9.7200				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.19675	.72701	.71259	.66288	.71259
.01	-.18796	.73694	.73688	.66363	.68830
.02	-.17917	.74654		.66823	.68057
.03	-.17038	.75581		.67068	.67644
.04	-.16159	.76473		.67297	.67474
.05	-.15280	.77332		.67510	.67511
.10	-.10884	.81094		.68323	
.15	-.06489	.83941		.68675	
.20	-.02093	.85824		.68513	
.25	.02303	.86701		.67781	
.30	.06698	.86535		.66423	
.35	.11094	.85296		.64384	
.40	.15490	.82962		.61616	
.45	.19885	.79520		.58077	
.50	.24281	.74970		.53737	
.55	.28677	.69318		.48580	
.60	.33072	.62583		.42604	
.65	.37468	.54792		.35824	
.70	.41863	.45984		.28266	
.75	.46259	.36230		.19967	
.80	.50655	.25627		.10971	
.85	.55050	.14281		.01326	
.90	.59446	.02291		-.08923	
.95	.63842	-.10260		-.19731	
.98	.66479	-.18031		-.26468	-.24882
.99	.67358	-.20659		-.28755	-.24829
1.00	.68237	-.23304	-.23531	-.31061	-.23531
LE Center	(-.15880,	.71259)	R = .03796		
TE Center	(.66839,	-.23531)	R = .01398		
Center of Gravity	(.23193,	.54275)			
Radial Reference	(.36300,	.53208)			
Gaging =	.34040				
Nose Point	(-.18988,	.69081)			
Tail Point	(.67308,	-.24848)			
LE Tangency Points	Top	(-.18679,	.73822)	Bottom (-.15190,	.67527)
TE Tangency Points	Top	(.68166,	-.23090)	Bottom (.65536,	-.24040)
Inlet Angle =	61.00703				
Exit Angle =	19.87875				
No. of Blades =	62				
Pitch =	.98504				
Tolerance =	-.00000				
Gaging =	.34040				
Uncovered Turning =	10.64472				
Gaging Angle =	20.21659				
Area =	.14300				
Axial Chord =	.87913				

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TABLE X
VANE 1 NORMAL SOLIDITY

Section FF	AT R = 7.57500				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.00002	.66720	.65449	.61888	.65449
.01	.00767	.67466	.67450	.62035	.63448
.02	.01532	.68180		.62175	.62835
.03	.02297	.68863		.62305	.62534
.04	.03062	.69513		.62427	.62451
.05	.03827	.70132		.62540	
.10	.07652	.72751		.62952	
.15	.11477	.74580		.63083	
.20	.15302	.75626		.62887	
.25	.19127	.75897		.62310	
.30	.22952	.75404		.61302	
.35	.26777	.74161		.59810	
.40	.30602	.72183		.57791	
.45	.34427	.69487		.55216	
.50	.38252	.66093		.52070	
.55	.42077	.62022		.48360	
.60	.45902	.57293		.44111	
.65	.49727	.51928		.39363	
.70	.53552	.45957		.34161	
.75	.57377	.39421		.28557	
.80	.61202	.32375		.22600	
.85	.65027	.24876		.16335	
.90	.68852	.16982		.09802	
.95	.72677	.08746		.03034	
.98	.74972	.03660		-.01127	-.00853
.99	.75737	.01943		-.02529	-.00973
1.00	.76502	.00215	.00003	-.03939	.00003
LE Center	(.03000,	.65449)	R = .02999		
TE Center	(.75497,	.00003)	R = .01004		
Center of Gravity	(.36346,	.53338)			
Radial Reference	(.36300,	.53208)			
Gaging =	.34367				
Nose Point	(.00395,	.63964)			
Tail Point	(.75938,	-.00900)			
LE Tangency Points	Top	(.00954,	.67641)	Bottom (.03437,	.62482)
TE Tangency Points	Top	(.76416,	.00409)	Bottom (.74617,	-.00480)
Inlet Angle =	64.30344				
Exit Angle =	26.31242				
No. of Blades =	62				
Pitch =	.76766				
Tolerance =	-.00000				
Gaging =	.34367				
Uncovered Turning =	12.36423				
Gaging Angle =	26.59496				
Area =	.08528				
Axial Chord =	.76500				

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TABLE XI
VANE 1 NORMAL SOLIDITY

Section GG		AT R = 10.30000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)	
.00	-.24997	.75347	.73671	.68817	.73671	
.01	-.24087	.76249	.76211	.69019	.71130	
.02	-.23177	.77125		.69209	.70316	
.03	-.22267	.77975		.69388	.69876	
.04	-.21357	.78798		.69553	.69685	
.05	-.20447	.79593		.69706		
.10	-.15897	.83141		.70261		
.15	-.11347	.85922		.70432		
.20	-.06797	.87865		.70162		
.25	-.02247	.88898		.69385		
.30	.02303	.88948		.68032		
.35	.06853	.87946		.66025		
.40	.11403	.85828		.63288		
.45	.15953	.82542		.59744		
.50	.20503	.78048		.55326		
.55	.25053	.72322		.49982		
.60	.29603	.65359		.43677		
.65	.34153	.57170		.36400		
.70	.38703	.47782		.28165		
.75	.43253	.37251		.19003		
.80	.47803	.25652		.08963		
.85	.52353	.13075		-.01896		
.90	.56903	-.00390		-.13514		
.95	.61453	-.14661		-.25832		
.98	.64183	-.23584		-.33536	-.31365	
.99	.65093	-.26615		-.36153	-.31276	
1.00	.66003	-.29675	-.29894	-.38795	-.29894	
LE Center	(-.20995,	.73671)	R = .04002			
TE Center	(.64498,	-.29894)	R = .01505			
Center of Gravity	(.20327,	.54248)				
Radial Reference	(.36300,	.53208)				
Gaging =	.33409					
Nose Point	(-.24442,	.71636)				
Tail Point	(.64957,	-.31327)				
LE Tangency Points	Top	(-.23771,	.76553)	Bottom	(-.20511,	.69698)
TE Tangency Points	Top	(.65940,	-.29465)	Bottom	(.63079,	-.30396)
Inlet Angle =	64.56346					
Exit Angle =	18.03789					
No. of Blades =	62					
Pitch =	1.04382					
Tolerance =	-.00000					
Gaging =	.33409					
Uncovered Turning =	11.20890					
Gaging Angle =	18.66710					
Area =	.15902					
Axial Chord =	.91000					

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TABLE XII
VANE 1 NORMAL SOLIDITY

Section HH	AT R - 10.26000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.24630	.75184	.73529	.68653	.73529
.01	-.23723	.76096	.76062	.68864	.70995
.02	-.22815	.76981		.69061	.70184
.03	-.21907	.77839		.69247	.69746
.04	-.20999	.78669		.69419	.69556
.05	-.20091	.79472		.69578	
.10	-.15552	.83043		.70157	
.15	-.11012	.85832		.70341	
.20	-.06473	.87771		.70973	
.25	-.01934	.88789		.69290	
.30	.02606	.88818		.67924	
.35	.07145	.87791		.65900	
.40	.11684	.85649		.63144	
.45	.16224	.82343		.59586	
.50	.20763	.77836		.55163	
.55	.25303	.72108		.49824	
.60	.29842	.65154		.43538	
.65	.34381	.56987		.36298	
.70	.38921	.47636		.28115	
.75	.43460	.37156		.19021	
.80	.47999	.25625		.09065	
.85	.52539	.13135		-.01699	
.90	.57078	-.00223		-.13211	
.95	.61617	-.14369		-.25413	
.98	.64341	-.23205		-.33044	-.30919
.99	.65249	-.26207		-.35637	-.30832
1.00	.66157	-.29235	-.29455	-.38254	-.29455
LE Center	(-.20641,	.73529)	R = .03989		
TE Center	(.64659,	-.29455)	R = .01498		
Center of Gravity	(.20520,	.54257)			
Radial Reference	(.36300,	.53208)			
Gaging =	.33459				
Nose Point	(-.24061,	.71475)			
Tail Point	(.65120,	-.30880)			
LE Tangency Points	Top	(-.23426,	.76385)	Bottom (-.20137,	.69572)
TE Tangency Points	Top	(.66094,	-.29025)	Bottom (.63248,	-.29958)
Inlet Angle =	64.22730				
Exit Angle =	18.16416				
No. of Blades =	62				
Pitch =	1.03977				
Tolerance =	-.00000				
Gaging =	.33459				
Uncovered Turning =	11.17851				
Gaging Angle =	18.77116				
Area =	.15813				
Axial Chord =	.90787				

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TABLE XIII
1ST STAGE BLADE

Section A-A		AT R = 7.69000			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.00289	.17492	.16995	.12020	.16995
.01	.00884	.18623		.12728	.15567
.02	.01479	.19709		.13395	.15160
.03	.02075	.20752		.14025	.14997
.04	.02670	.21754		.14622	.15019
.05	.03265	.22717		.15188	.15232
.10	.06241	.27003		.17619	
.15	.09217	.30515		.19507	
.20	.12193	.33357		.20961	
.25	.15169	.35600		.22042	
.30	.18145	.37289		.22793	
.35	.21121	.38454		.23236	
.40	.24097	.39113		.23388	
.45	.27073	.39270		.23254	
.50	.30049	.38922		.22834	
.55	.33025	.38055		.22120	
.60	.36001	.36640		.21095	
.65	.38977	.34635		.19735	
.70	.41953	.31976		.18010	
.75	.44929	.28563		.15876	
.80	.47905	.24270		.13262	
.85	.50881	.19073		.10067	
.90	.53857	.13122		.06138	
.95	.56833	.06633		.01235	
.98	.58619	.02560		-.02348	-.01421
.99	.59214	.01179		-.03684	-.01345
1.00	.59209	-.00212	-.00421	-.05105	-.00421
LE Center	(.02299,	.16995)	R = .02010		
TE Center	(.58793,	-.00421)	R = .01016		
Center of Gravity	(.29215,	.25746)			
Radial Reference	(.29145,	.25568)			
Gaging =	.17723				
Nose Point	(.01169,	.15333)			
Tail Point	(.59203,	-.01350)			
LE Tangency Points	Top	(.00520,	.17931)	Bottom (.03571,	.15438)
TE Tangency Points	Top	(.59727,	-.00021)	Bottom (.57884,	-.00874)
Inlet Angle =	39.25663				
Exit Angle =	24.82772				
No. of Blades =	116				
Pitch =	.41653				
Tolerance =	.00000				
Gaging =	.17723				
Uncovered Turning =	16.20657				
Gaging Angle =	25.18208				
Area =	.07117				
Axial Chord =	.59520				

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TABLE XIV
1ST STAGE BLADE

Section B-B		AT R = 8.35560			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.01550	.19956	.19463	.14702	.19463
.01	.02133	.21073		.15355	.18047
.02	.02716	.22145		.15971	.17638
.03	.03299	.23175		.16552	.17469
.04	.03882	.24163		.17102	.17478
.05	.04465	.25113		.17623	.17667
.10	.07380	.29324		.19851	
.15	.10295	.32742		.21564	
.20	.13210	.35465		.22859	
.25	.16125	.37560		.23793	
.30	.19040	.39072		.24403	
.35	.21955	.40030		.24708	
.40	.24870	.40452		.24718	
.45	.27785	.40342		.24436	
.50	.30700	.39697		.23853	
.55	.33615	.38502		.22956	
.60	.36530	.36729		.21720	
.65	.39445	.34336		.20110	
.70	.42360	.31260		.18081	
.75	.45275	.27407		.15575	
.80	.48190	.22716		.12528	
.85	.51105	.17258		.08864	
.90	.54020	.11207		.04502	
.95	.56935	.04737		-.00654	
.98	.58684	.00713		-.04177	-.03219
.99	.59267	-.00648		-.05430	-.03137
1.0	.59850	-.02016	-.02222	-.06723	-.02222
LE Center	(.03561,	.19463)	R = .02011		
TE Center	(.58840,	-.02222)	R = .01010		
Center of Gravity	(.29528,	.26554)			
Radial Reference	(.29145,	.25568)			
Gaging =	.19201				
Nose Point	(.02418,	.17808)			
Tail Point	(.59253,	-.03143)			
LE Tangency Points	Top	(.01778,	.20393)	Bottom (.04782,	.17865)
TE Tangency Points	Top	(.59769,	-.01826)	Bottom (.57936,	-.02671)
Inlet Angle =	40.08727				
Exit Angle =	24.74051				
No. of Blades =	116				
Pitch =	.45258				
Tolerance =	.00000				
Gaging =	.19201				
Uncovered Turning =	15.75148				
Gaging Angle =	25.10380				
Area =	.06843				
Axial Chord =	.58300				

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TABLE XV
1ST STAGE BLADE

Section C-C		AT R = 9.17380			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.03100	.23102	.22627	.17999	.22627
.01	.03668	.24239		.18616	.21226
.02	.04236	.25325		.19196	.20815
.03	.04804	.26362		.19741	.20638
.04	.05372	.27353		.20256	.20631
.05	.05940	.28301		.20741	.20793
.10	.08780	.32438		.22800	
.15	.11620	.35701		.24353	
.20	.14460	.38208		.25492	
.25	.17300	.40040		.26273	
.30	.20140	.41250		.26727	
.35	.22980	.41873		.26872	
.40	.25820	.41930		.26712	
.45	.28660	.41429		.26242	
.50	.31500	.40368		.25446	
.55	.34340	.38733		.24294	
.60	.37180	.36499		.22741	
.65	.40020	.33621		.20724	
.70	.42860	.30036		.18172	
.75	.45700	.25679		.15037	
.80	.48540	.20584		.11313	
.85	.51380	.14886		.07025	
.90	.54220	.08749		.02206	
.95	.57060	.02307		-.03116	
.98	.58764	-.01664		-.06542	-.05545
.99	.59332	-.03001		-.07722	-.05454
1.00	.59900	-.04345	-.04549	-.08921	-.04549
LE Center		(.05113,	.22627)	R = .02012	
TE Center		(.58495,	-.04549)	R = .01005	
Center of Gravity		(.29953,	.27541)		
Radial Reference		(.29145,	.25568)		
Gaging =		.20887			
Nose Point		(.03981,	.20963)		
Tail Point		(.59309,	-.05464)		
LE Tangency Points		Top	(.03312,	.23526)	Bottom (.06294,
TE Tangency Points		Top	(.59821,	-.04157)	Bottom (.57995,
Inlet Angle =		40.29964			
Exit Angle =		24.68013			
No. of Blades =		116			
Pitch =		.49690			
Tolerance =		.00000			
Gaging =		.20887			
Uncovered Turning =		15.25190			
Gaging Angle =		24.85676			
Area =		.06385			
Axial Chord =		.56800			

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TABLE XVI
1ST STAGE BLADE

Section D-D		ATR = 9.99190			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.04650	.27190	.26721	.22290	.26721
.01	.05203	.28314		.22859	.25335
.02	.05756	.29384		.23392	.24924
.03	.06309	.30402		.23891	.24739
.04	.06862	.31371		.24361	.24717
.05	.07415	.32293		.24802	.24853
.10	.10180	.36262		.26647	
.15	.12945	.39292		.27992	
.20	.15710	.41509		.28928	
.25	.18475	.42998		.29502	
.30	.21240	.43819		.29741	
.35	.24005	.44011		.29655	
.40	.26770	.43599		.29241	
.45	.29535	.42595		.28480	
.50	.32300	.41003		.27337	
.55	.35065	.38812		.25749	
.60	.37830	.36002		.23619	
.65	.40595	.32539		.20848	
.70	.43360	.28378		.17442	
.75	.46125	.23534		.13504	
.80	.48890	.18107		.09139	
.85	.51655	.12233		.04419	
.90	.54420	.06036		-.00607	
.95	.57185	-.00390		-.05906	
.98	.58844	-.04327		-.09204	-.08176
.99	.59397	-.05650		-.10323	-.08075
1.00	.59950	-.06978	-.07179	-.11451	-.07179
LE Center		(.06664,	.26721)	R = .02014	
TE Center		(.58947,	-.07179)	R = .01003	
Center of Gravity		(.30623,	.28525)		
Radial Reference		(.29145,	.25568)		
Gaging =		.22316			
Nose Point		(.05524,	.25061)		
Tail Point		(.59361,	-.08092)		
LE Tangency Points		Top	(.04857,	.27610)	Bottom (.07781,
TE Tangency Points		Top	(.59873,	-.06793)	Bottom (.58052,
Inlet Angle =		41.24153			.25046)
Exit Angle =		24.65380			-.07629)
No. of Blades =		116			
Pitch =		.54122			
Tolerance =		.00000			
Gaging =		.22316			
Uncovered Turning =		14.16920			
Gaging Angle =		24.35155			
Area =		.05927			
Axial Chord =		.55300			

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TABLE XVII
1ST STAGE BLADE

Section E-E		AT R = 10.35000			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.05328	.31086	.30581	.26449	.30581
.01	.05875	.32111		.26952	.29200
.02	.06421	.33085		.27422	.28787
.03	.06968	.34012		.27862	.28598
.04	.07514	.34893		.28274	.28569
.05	.08061	.35723		.28660	.28692
.10	.10793	.39300		.30249	
.15	.13525	.41961		.31360	
.20	.16257	.43820		.32067	
.25	.18989	.44955		.32409	
.30	.21721	.45419		.32401	
.35	.24454	.45250		.32040	
.40	.27186	.44473		.31304	
.45	.29918	.43103		.30142	
.50	.32650	.41147		.28487	
.55	.35382	.38600		.26319	
.60	.38114	.35451		.23619	
.65	.40847	.31677		.20346	
.70	.43579	.27257		.16537	
.75	.46311	.22233		.12308	
.80	.49043	.16712		.07760	
.85	.51775	.10810		.02956	
.90	.54507	.04631		-.02068	
.95	.57240	-.01750		-.07288	
.98	.58879	-.05651		-.10505	-.09474
.99	.59425	-.06961		-.11591	-.09369
1.00	.59972	-.08277	-.08476	-.12683	-.08476
LE Center	(.07348,	.30581)	R = .02019		
TE Center	(.58970,	-.08476)	R = .01002		
Center of Gravity	(.31311,	.29070)			
Radial Reference	(.29145,	.25568)			
Gaging =	.22960				
Nose Point	(.06135,	.28967)			
Tail Point	(.59385,	-.09388)			
LE Tangency Points	Top	(.05566,	.31531)	Bottom (.08363,	.28836)
TE Tangency Points	Top	(.59895,	-.08092)	Bottom (.58077,	-.08931)
Inlet Angle =	43.93851				
Exit Angle =	24.78400				
No. of Blades =	116				
Pitch =	.56061				
Tolerance =	.00000				
Gaging =	.22960				
Uncovered Turning =	13.29798				
Gaging Angle =	24.17658				
Area =	.05559				
Axial Chord =	.54643				

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TABLE XVIII
1ST STAGE BLADE

Section F-F		AT R = 7.53750			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.00000	.16961	.16465	.11426	.16465
.01	.00598	.18100		.12150	.15035
.02	.01196	.19192		.12832	.14627
.03	.01794	.20240		.13477	.14466
.04	.02392	.21246		.14087	.14491
.05	.02990	.22213		.14665	.14709
.10	.05980	.26514		.17150	
.15	.08970	.30039		.19085	
.20	.11960	.32897		.20578	
.25	.14950	.35160		.21695	
.30	.17940	.36877		.22478	
.35	.20930	.38078		.22953	
.40	.23920	.38780		.23135	
.45	.26910	.38990		.23032	
.50	.29900	.38705		.22644	
.55	.32890	.37909		.21965	
.60	.35880	.36575		.20982	
.65	.38870	.34661		.19674	
.70	.41860	.32100		.18010	
.75	.44850	.28793		.15945	
.80	.47840	.24601		.13412	
.85	.50830	.19473		.10314	
.90	.53820	.13551		.06488	
.95	.56810	.07060		.01657	
.98	.58604	.02975		-.01938	-.01018
.99	.59202	.01589		-.03295	-.00943
1.00	.59800	.00193	-.00015	-.04753	-.00015
LE Center	(.02011,	.16465)	R = .02011		
TE Center	(.58782,	.00015)	R = .01018		
Center of Gravity	(.29147,	.25565)			
Radial Reference	(.29145,	.25568)			
Gaging =	.17374				
Nose Point	(.00886,	.14799)			
Tail Point	(.59191,	-.00947)			
LE Tangency Points	Top	(.00231,	.17400)	Bottom (.03296,	.14919)
TE Tangency Points	Top	(.59718,	.00385)	Bottom (.57871,	-.00470)
Inlet Angle =	38.98929				
Exit Angle =	24.85609				
No. of Blades =	116				
Pitch =	.40827				
Tolerance =	.00000				
Gaging =	.17374				
Uncovered Turning =	16.32820				
Gaging Angle =	25.18580				
Area =	.07158				
Axial Chord =	.59800				

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TABLE XIX
1ST STAGE 3LADE

Section G-G	AT R = 10.81000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.06200	.38628	.38006	.34537	.38006
.01	.06738	.39413		.34901	.36639
.02	.07276	.40158		.35240	.36229
.03	.07814	.40867		.35555	.36039
.04	.08352	.41538		.35848	.36005
.05	.08890	.42174		.36119	.36120
.10	.11580	.44834		.37184	
.15	.14270	.46692		.37819	
.20	.16960	.47810		.38064	
.25	.19650	.48239		.37936	
.30	.22340	.48018		.37426	
.35	.25030	.47178		.36503	
.40	.27720	.45743		.35099	
.45	.30410	.43732		.33088	
.50	.33100	.41158		.30339	
.55	.35790	.38030		.26960	
.60	.38480	.34350		.23164	
.65	.41170	.30120		.19074	
.70	.43860	.25368		.14755	
.75	.46550	.20156		.10249	
.80	.49240	.14570		.05579	
.85	.51930	.08691		.00769	
.90	.54620	.02588		-.04169	
.95	.57310	-.03685		-.09222	
.98	.58924	-.07513		-.12305	-.11287
.99	.59462	-.08798		-.13341	-.11176
1.00	.60000	-.10088	-.10288	-.14381	-.10288
LE Center	(.08206,	.38006)	R = .02006		
TE Center	(.58998,	-.10288)	R = .01001		
Center of Gravity	(.32762,	.29499)			
Radial Reference	(.29145,	.25568)			
Gaging =	.23790				
Nose Point	(.06802,	.36573)			
Tail Point	(.59419,	-.11197)			
LE Tangency Points	Top	(.06551,	.39141)	Bottom (.08945,	.36141)
TE Tangency Points	Top	(.59923,	-.09903)	Bottom (.58111,	-.10753)
Inlet Angle =	51.41446				
Exit Angle =	25.14093				
No. of Blades =	116				
Pitch =	.58553				
Tolerance =	.00000				
Gaging =	.23790				
Uncovered Turning =	11.60881				
Gaging Angle =	23.97302				
Area =	.04878				
Axial Chord =	.53800				

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TABLE XX
VANE 2 NORMAL SOLIDITY

Section AA		AT R = 7.65000			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.00825	.27803	.27272	.22125	.27272
.01	.00010	.29295		.23104	.25628
.02	.00846	.30733		.24024	.25270
.03	.01682	.32120		.24892	.25293
.04	.02518	.33457		.25711	.25714
.05	.03353	.34745		.26485	
.10	.07532	.40483		.29785	
.15	.11711	.45137		.32315	
.20	.15889	.48800		.34225	
.25	.20068	.51543		.35605	
.30	.24246	.53419		.36509	
.35	.28425	.54470		.36969	
.40	.32604	.54724		.37000	
.45	.36782	.54203		.36602	
.50	.40961	.52916		.35763	
.55	.45140	.50867		.34455	
.60	.49318	.48049		.32631	
.65	.53497	.44448		.30218	
.70	.57675	.40038		.27135	
.75	.61854	.34789		.23334	
.80	.66033	.28719		.18831	
.85	.70211	.21953		.13700	
.90	.74390	.14656		.08024	
.95	.78569	.06980		.01872	
.98	.81076	.02238		-.02024	-.01956
.99	.81912	.00640		-.03355	-.02200
1.00	.82747	-.00968	-.01212	-.04702	-.01212
LE Center	(.01209,	.27272)	R = .02035		
TE Center	(.81746,	-.01212)	R = -.01001		
Center of Gravity	(.38024,	.37616)			
Radial Reference	(.38657,	.37155)			
Gaging =	.29534				
Nose Point	(.00042,	.25606)			
Tail Point	(.82240,	-.02083)			
LE Tangency Points	Top	(-.00566,	.28266)	Bottom (.02592,	.25779)
TE Tangency Points	Top	(.82634,	-.00750)	Bottom (.80901,	-.01749)
Inlet Angle =	38.22600				
Exit Angle =	29.95553				
No. of Blades =	80				
Pitch =	.60083				
Tolerance =	-.00000				
Gaging =	.29534				
Uncovered Turning =	12.68384				
Gaging Angle =	29.44311				
Area =	.10554				
Axial Chord =	.83573				

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TABLE XXI
VANE 2 NORMAL SOLIDITY

Section BB					
AT R = 8.48630					
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.05433	.36436	.35790	.30836	.35790
.01	-.04577	.37804		.31659	.34024
.02	-.03720	.39122		.32436	.33606
.03	-.02864	.40393		.33168	.33565
.04	-.02007	.41617		.33860	.33874
.05	-.01151	.42795		.34514	
.10	.03132	.48019		.37282	
.15	.07414	.52188		.39347	
.20	.11697	.55368		.40824	
.25	.15979	.57609		.41777	
.30	.20262	.58949		.42246	
.35	.24544	.59421		.42247	
.40	.28827	.59045		.41780	
.45	.33109	.57840		.40830	
.50	.37392	.55813		.39360	
.55	.41674	.52970		.37310	
.60	.45957	.49307		.34592	
.65	.50239	.44816		.31105	
.70	.54522	.39481		.26804	
.75	.58804	.33283		.21744	
.80	.63087	.26256		.16030	
.85	.67369	.18506		.09754	
.90	.71652	.10171		.02986	
.95	.75934	.01384		-.04224	
.98	.78504	-.04061		-.08747	-.08675
.99	.79360	-.05900		-.10286	-.08962
1.00	.80217	-.07751	-.07971	-.11842	-.07971
LE Center	(-.03185,	.35790)	R = .02249		
TE Center	(.79216,	-.07971)	R = .01001		
Center of Gravity	(.34599,	.40263)			
Radial Reference	(.38657,	.37155)			
Gaging =	.30273				
Nose Point	(-.04599,	.34042)			
Tail Point	(.79667,	-.08865)			
LE Tangency Points	Top	(-.05090,	.36984)	Bottom (-.01820,	.34003)
TE Tangency Points	Top	(.80124,	-.07551)	Bottom (.78344,	-.08462)
Inlet Angle =	42.35586				
Exit Angle =	27.08955				
No. of Blades =	80				
Pitch =	.66651				
Tolerance =	-.00000				
Gaging =	.30273				
Uncovered Turning =	12.14270				
Gaging Angle =	27.01327				
Area =	.10714				
Axial Chord =	.85650				

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TABLE XXII
VANE 2 NORMAL SOLIDITY

Section CC		AT R = 9.47250				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)	
.00	-.10867	.47405	.46529	.42136	.46529	
.01	-.09986	.48508		.42709	.44623	
.02	-.09105	.49579		.43249	.44139	
.03	-.08224	.50619		.43760	.44032	
.04	-.07343	.51626		.44242	.44247	
.05	-.06462	.52602		.44697		
.10	-.02057	.56987		.46588		
.15	.02348	.60524		.47904		
.20	.06753	.63184		.48702		
.25	.11158	.64940		.49012		
.30	.15563	.65771		.48845		
.35	.19968	.65662		.48195		
.40	.24373	.64604		.47039		
.45	.28778	.62596		.45332		
.50	.33183	.59643		.43002		
.55	.37588	.55755		.39942		
.60	.41993	.50951		.36040		
.65	.46398	.45252		.31251		
.70	.50803	.38685		.25644		
.75	.55208	.31283		.19330		
.80	.59613	.23104		.12407		
.85	.64018	.14225		.04946		
.90	.68423	.04734		-.03006		
.95	.72828	-.05281		-.11409		
.98	.75471	-.11509		-.16657	-.16591	
.99	.76352	-.13618		-.18440	-.16936	
1.00	.77233	-.15743	-.15942	-.20239	-.15942	
LE Center	(-.08366,	.46529)	R = .02501			
TE Center	(.76232,	-.15942	R = .01001			
Center of Gravity	(.30809,	.43300)				
Radial Reference	(.38657,	.37155)				
Gaging =	.31081					
Nose Point	(-.10204,	.44832)				
Tail Point	(.76643,	-.16855)				
LE Tangency Points	Top	(-.10320,	.48090)	Bottom	(-.07220,	.44306)
TE Tangency Points	Top	(.77157,	-.15559)	Bottom	(.75337,	-.16389)
Inlet Angle =	50.66591					
Exit Angle =	24.51642					
No. of Blades =	80					
Pitch =	.74397					
Tolerance =	-.00000					
Gaging =	.31081					
Uncovered Turning =	10.76521					
Gaging Angle =	24.69407					
Area =	.11199					
Axial Chord =	.88100					

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TABLE XXIII

VANE 2 NORMAL SOLIDITY

Section DD	AT R = 10.45880				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.16301	.53978	.52875	.48815	.52875
.01	-.15396	.54925		.49213	.50835
.02	-.14490	.55844		.49588	.50290
.03	-.13585	.56735		.49938	.50125
.04	-.12679	.57597		.50266	.50266
.05	-.11774	.58430		.50572	
.10	-.07246	.62145		.51779	
.15	-.02719	.65071		.52482	
.20	.01809	.67158		.52706	
.25	.06336	.68360		.52457	
.30	.10864	.68637		.51729	
.35	.15391	.67956		.50495	
.40	.19919	.66293		.48711	
.45	.24446	.63636		.46304	
.50	.28974	.59981		.43171	
.55	.33501	.55338		.39192	
.60	.38029	.49726		.34307	
.65	.42556	.43173		.28569	
.70	.47084	.35717		.22082	
.75	.51611	.27409		.14947	
.80	.56139	.18330		.07241	
.85	.60666	.08580		-.00984	
.90	.65194	-.01739		-.09689	
.95	.69721	-.12534		-.18841	
.98	.72438	-.19204		-.24540	-.24500
.99	.73343	-.21456		-.26473	-.24910
1.00	.74249	-.23721	-.23914	-.28422	-.23914
LE Center	(-.13551,	.52875)	R = .02750		
TE Center	(.73248,	-.23914)	R = .01000		
Center of Gravity	(.26862,	.43211			
Radial Reference	(.38657,	.37155)			
Gaging =	.32995				
Nose Point	(-.15780,	.51263)			
Tail Point	(.73644,	-.24833)			
LE Tangency Points	Top	(-.15539,	.54776) Bottom	(-.12672,	.50269)
TE Tangency Points	Top	(.74177,	-.23542) Bottom	(.72344,	-.24341)
Inlet Angle =	57.53765				
Exit Angle =	23.53890				
No. of Blades =	80				
Pitch =	.82143				
Tolerance =	-.00000				
Gaging =	.32995				
Uncovered Turning =	9.87775				
Gaging Angle =	23.68281				
Area =	.11685				
Axial Chord =	.90550				

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TABLE XXIV
VANE 2 NORMAL SOLIDITY

Section EE	AT R = 10.86000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.18512	.54432	.53241	.49290	.53241
.01	-.17596	.55336		.49623	.51147
.02	-.16681	.56215		.49937	.50578
.03	-.15765	.57066		.50231	.50391
.04	-.14850	.57891		.50506	
.05	-.13934	.58689		.50763	
.10	-.09357	.62255		.51774	
.15	-.04780	.65077		.52341	
.20	-.00202	.67099		.52465	
.25	.04375	.68267		.52135	
.30	.08952	.68529		.51325	
.35	.13530	.67839		.49994	
.40	.18107	.66157		.48087	
.45	.22684	.63456		.45527	
.50	.27262	.59720		.42213	
.55	.31839	.54947		.38045	
.60	.36416	.49149		.32978	
.65	.40994	.42350		.27067	
.70	.45571	.34589		.20399	
.75	.50148	.25926		.13056	
.80	.54725	.16466		.05108	
.85	.59303	.06333		-.03390	
.90	.63880	-.04350		-.12391	
.95	.68457	-.15479		-.21854	
.98	.71204	-.22333		-.27743	-.27713
.99	.72119	-.24644		-.29739	-.28153
1.00	.73035	-.26966	-.27156	-.31752	-.27156
LE Center	(-.15660,	.53241)	R = .02852		
TE Center	(.72035,	-.27156)	R = .01000		
Center of Gravity	(.25247,	.42380)			
Radial Reference	(.38657,	.37155)			
Gaging =	.33710				
Nose Point	(-.18040,	.51670)			
Tail Point	(.72424,	-.28077)			
LE Tangency Points	Top	(-.17664,	.55270) Bottom	(-.14890,	.50495)
TE Tangency Points	Top	(.72965,	-.26789) Bottom	(.71127,	-.27576)
Inlet Angle =	59.84638				
Exit Angle =	23.16488				
No. of Blades =	80				
Pitch =	.85294				
Tolerance =	-.00000				
Gaging =	.33710				
Uncovered Turning =	9.69143				
Gaging Angle =	23.27951				
Area =	.12135				
Axial Chord =	.91547				

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TABLE XXV

VANE 2 NORMAL SOLIDITY

Section FF	AT R = 7.50000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.00001	.26416	.25899	.20756	.25899
.01	.00833	.27915		.21753	.24278
.02	.01665	.29362		.22691	.23931
.03	.02497	.30758		.23574	.23967
.04	.03329	.32104		.24408	.24412
.05	.04161	.33402		.25196	
.10	.08321	.39206		.28562	
.15	.12481	.43944		.31152	
.20	.16641	.47704		.33122	
.25	.20801	.50555		.34565	
.30	.24961	.52546		.35535	
.35	.29121	.53717		.36067	
.40	.33281	.54093		.36177	
.45	.37441	.53696		.35868	
.50	.41601	.52534		.35131	
.55	.45761	.50611		.33944	
.60	.49921	.47923		.32265	
.65	.54081	.44455		.30036	
.70	.58241	.40188		.27176	
.75	.62401	.35091		.23616	
.80	.66561	.29183		.19344	
.85	.70721	.22589		.14424	
.90	.74881	.15476		.08942	
.95	.79041	.07994		.02973	
.98	.81537	.03373		-.00817	-.00750
.99	.82369	.01816		-.02114	-.00987
1.00	.83201	.00250	.00000	-.03426	.00000
LE Center	(.01997,	.25899)	R = .01996		
TE Center	(.82200,	.00000)	R = .01001		
Center of Gravity	(.38670,	.37210)			
Radial Reference	(.38657,	.37155)			
Gaging =	.29359				
Nose Point	(.00863,	.24257)			
Tail Point	(.82702,	-.00866)			
LE Tangency Points	Top	(.00252,	.26868) Bottom	(.03410,	.24489)
TE Tangency Points	Top	(.83084,	.00470) Bottom	(.81360,	-.00545)
Inlet Angle =	36.98468				
Exit Angle =	30.50032				
No. of Blades =	80				
Pitch =	.58905				
Tolerance =	-.00000				
Gaging =	.29359				
Uncovered Turning =	12.64424				
Gaging Angle =	29.89479				
Area =	.10561				
Axial Chord =	.83200				

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TABLE XXVI
VANE 2 NORMAL SOLIDITY

Section GG		AT R = 11.44500			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.21735	.52544	.51223	.47443	.51223
.01	-.20805	.53395	.53393	.47674	.49052
.02	-.19875	.54226		.47896	.48449
.03	-.18945	.55036		.48109	.48232
.04	-.18015	.55825		.48312	
.05	-.17085	.56593		.48505	
.10	-.12435	.60091		.49311	
.15	-.07785	.62969		.49817	
.20	-.03135	.65155		.49973	
.25	.01515	.66568		.49719	
.30	.06165	.67128		.48989	
.35	.10815	.66753		.47711	
.40	.15465	.65368		.45807	
.45	.20115	.62905		.43203	
.50	.24765	.59315		.39830	
.55	.29415	.54567		.35636	
.60	.34065	.48652		.30590	
.65	.38715	.41584		.24688	
.70	.43365	.33402		.17953	
.75	.48015	.24191		.10430	
.80	.52665	.14110		.02183	
.85	.57315	.03337		-.06719	
.90	.61965	-.07968		-.16202	
.95	.66615	-.19679		-.26198	
.98	.69405	-.26859		-.32413	-.32396
.99	.70335	-.29274		-.34518	-.32882
1.00	.71265	-.31699	-.31884	-.36640	-.31884
LE Center	(-.18737,	.51223)	R = .02998		
TE Center	(.70265,	-.31884)	R = .01000		
Center of Gravity	(.22900,	.40506)			
Radial Reference	(.38657,	.37155)			
Gaging =	.34502				
Nose Point	(-.21338,	.49731)			
Tail Point	(.70644,	-.32810)			
LE Tangency Points	Top	(-.20734,	.53458) Bottom	(-.18098,	.48294)
TE Tangency Points	Top	(.71199,	-.31526) Bottom	(.69351,	-.32291)
Inlet Angle =	62.95352				
Exit Angle =	22.48960				
No. of Blades =	80				
Pitch =	.89889				
Tolerance =	-.00000				
Gaging =	.34502				
Uncovered Turning =	9.65333				
Gaging Angle =	22.57141				
Area =	.13190				
Axial Chord =	.93000				

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TABLE XXVII
VANE 2 NORMAL SOLIDITY

Section HH	AT R = 11.41000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	-.21542	.52742	.51428	.47638	.51428
.01	-.20613	.53596	.53594	.47876	.49262
.02	-.19684	.54429		.48103	.48661
.03	-.18755	.55241		.48321	.48446
.04	-.17826	.56032		.48528	
.05	-.16897	.56801		.48725	
.10	-.12251	.60298		.49540	
.15	-.07605	.63166		.50046	
.20	-.02960	.65333		.50193	
.25	.01686	.66722		.49929	
.30	.06332	.67253		.49187	
.35	.10977	.66849		.47899	
.40	.15623	.65435		.45990	
.45	.20269	.62948		.43382	
.50	.24914	.59340		.40006	
.55	.29560	.54583		.35805	
.60	.34206	.48670		.30748	
.65	.38851	.41616		.24837	
.70	.43497	.33457		.18099	
.75	.48143	.24281		.10583	
.80	.52788	.14239		.02352	
.85	.57434	.03507		-.06526	
.90	.62080	-.07758		-.15979	
.95	.66725	-.19431		-.25939	
.98	.69513	-.26589		-.32134	-.32116
.99	.70442	-.28997		-.34232	-.32599
1.00	.71371	-.31416	-.31602	-.36346	-.31602
LE Center	(-.18553,	.51428)	R = .02989		
TE Center	(.70371,	-.31602)	R = .01000		
Center of Gravity	(.23041,	.40640)			
Radial Reference	(.38657,	.37155)			
Gaging =	.34463				
Nose Point	(-.21140,	.49931)			
Tail Point	(.70751,	-.32527)			
LE Tangency Points	Top	(-.20549,	.53654) Bottom	(-.17902,	.48511)
TE Tangency Points	Top	(.71304,	-.31243) Bottom	(.69457,	-.32009)
Inlet Angle =	62.77019				
Exit Angle =	22.53380				
No. of Blades =	80				
Pitch =	.89614				
Tolerance =	-.00000				
Gaging =	.34463				
Uncovered Turning =	9.63787				
Gaging Angle =	22.61714				
Area =	.13113				
Axial Chord =	.92913				

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TABLE XXVIII
2ND STAGE BLADE

Section A-A		AT R = 7.71000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)	
.00	.00469	.11660	.10985	.06764	.10985	
.01	.01118	.12496		.07364	.09524	
.02	.01766	.13302		.07933	.09133	
.03	.02414	.14079		.08473	.09014	
.04	.03063	.14829		.08986	.09115	
.05	.03711	.15552		.09475		
.10	.06952	.18789		.11589		
.15	.10194	.21453		.13245		
.20	.13435	.23600		.14521		
.25	.16677	.25269		.15470		
.30	.19918	.26489		.16123		
.35	.23160	.27280		.16503		
.40	.26401	.27657		.16625		
.45	.29642	.27626		.16498		
.50	.32884	.27192		.16126		
.55	.36125	.26350		.15513		
.60	.39367	.25094		.14653		
.65	.42608	.23410		.13539		
.70	.45850	.21276		.12143		
.75	.49091	.18658		.10441		
.80	.52333	.15517		.08396		
.85	.55574	.11857		.05961		
.90	.58815	.07763		.03065		
.95	.62057	.03353		-.00408		
.98	.64002	.00596		-.02854	-.02560	
.99	.64650	-.00337		-.03747	-.02535	
1.00	.65298	-.01277	-.01592	-.04686	-.01592	
LE Center		(.02440,	.10985)	R = .01971		
TE Center		(.64288,	-.01592)	R = .01010		
Center of Gravity		(.31188,	.17693)			
Radial Reference		(.31261,	.17488)			
Gaging =		.22692				
Nose Point		(.01090,	.09549)			
Tail Point		(.64873,	-.02416)			
LE Tangency Points		Top	(.00883,	.12193) Bottom	(.03626,	.09411)
TE Tangency Points		Top	(.65120,	-.01018) Bottom	(.63498,	-.02220)
Inlet Angle =		45.40499				
Exit Angle =		36.54155				
No. of Blades =		126				
Pitch =		.38447				
Tolerance =		-.00000				
Gaging =		.22692				
Uncovered Turning =		14.50464				
Gaging Angle =		36.17168				
Area =		.05416				
Axial Chord =		.64829				

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TABLE XXIX
2ND STAGE BLADE

Section B-B		AT R = 8.58630			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.02115	.15901	.15268	.11388	.15268
.01	.02733	.16711		.11929	.13877
.03	.03350	.17492		.12442	.13506
.03	.03968	.18244		.12929	.13394
.04	.04586	.18969		.13392	.13491
.05	.05204	.19666		.13832	
.10	.08292	.22760		.15717	
.15	.11381	.25238		.17152	
.20	.14470	.27143		.18198	
.25	.17559	.28511		.18896	
.30	.20647	.29366		.19270	
.35	.23736	.29731		.19333	
.40	.26825	.29621		.19092	
.45	.29914	.29046		.18547	
.50	.33002	.28014		.17695	
.55	.36091	.26528		.16527	
.60	.39180	.24588		.15034	
.65	.42269	.22190		.13207	
.70	.45357	.19328		.11035	
.75	.48446	.15989		.08506	
.80	.51535	.12187		.05609	
.85	.54624	.07975		.02332	
.90	.57712	.03429		-.01341	
.95	.60801	-.01377		-.05428	
.98	.62654	-.04357		-.08088	-.07638
.99	.63272	-.05364		-.09011	-.07587
1.00	.63890	-.06377	-.06660	-.09952	-.06660
LE Center	(.03989,	.15268)	R = .01874		
TE Center	(.62885,	-.06660)	R = .01005		
Center of Gravity	(.31234,	.18537)			
Radial Reference	(.31261,	.17488)			
Gaging =	.23291				
Nose Point	(.02699,	.13909)			
Tail Point	(.63427,	-.07507)			
LE Tangency Points	Top	(.02499,	.16404) Bottom	(.05076,	.13740)
TE Tangency Points	Top	(.63743,	-.06136) Bottom	(.62060,	-.07234)
Inlet Angle =	45.94590				
Exit Angle =	33.11900				
No. of Blades =	126				
Pitch =	.42817				
Tolerance =	-.00000				
Gaging =	.23291				
Uncovered Turning =	13.27063				
Gaging Angle =	32.95342				
Area =	.04913				
Axial Chord =	.61775				

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TABLE XXX
2ND STAGE BLADE

Section C-C		ATR = 9.71250			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.04230	.21675	.21090	.17605	.21090
.01	.04808	.22443		.18087	.19790
.02	.05387	.23180		.18541	.19444
.03	.05965	.23886		.18967	.19340
.04	.06544	.24562		.19369	.19434
.05	.07122	.25209		.19747	
.10	.10015	.28019		.21319	
.15	.12907	.30162		.22435	
.20	.15800	.31683		.23159	
.25	.18692	.32618		.23525	
.30	.21585	.32996		.23549	
.35	.24477	.32839		.23233	
.40	.27370	.32166		.22565	
.45	.30262	.30990		.21520	
.50	.33155	.29321		.20065	
.55	.36047	.27166		.18164	
.60	.38940	.24527		.15805	
.65	.41832	.21404		.13011	
.70	.44725	.17795		.09823	
.75	.47617	.13713		.06285	
.80	.50510	.09203		.02431	
.85	.53402	.04336		-.01710	
.90	.56295	-.00817		-.06118	
.95	.59187	-.06194		-.10776	
.98	.60923	-.09505		-.13685	-.12976
.99	.61501	-.10620		-.14673	-.12894
1.00	.62080	-.11742	-.11985	-.15670	-.11985
LE Center	(.05979)	.21090	R = .01750		
TE Center	(.61077,	-.11985)	R = .01003		
Center of Gravity	(.31975,	.19589)			
Radial Reference	(.31261,	.17488)			
Gaging =	.23405				
Nose Point	(.04765,	.19831)			
Tail Point	(.61560,	-.12864)			
LE Tangency Points	Top	(.04582,	.22143) Bottom	(.06936,	.19625)
TE Tangency Points	Top	(.61968,	-.11525) Bottom	(.60215,	-.12499)
Inlet Angle =	46.92461				
Exit Angle =	29.05572				
No. of Blades =	126				
Pitch =	.48433				
Tolerance =	-.00000				
Gaging =	.23405				
Uncovered Turning =	12.73546				
Gaging Angle =	28.89695				
Area =	.04379				
Axial Chord =	.57850				

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TABLE XXXI
2ND STAGE BLADE

Section D-D		AT R = 10.83880			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.06345	.28704	.28052	.25413	.28052
.01	.06884	.29268		.25716	.26842
.02	.07423	.29814		.25999	.26521
.03	.07962	.30342		.26264	.26426
.04	.08502	.30853		.26511	.26515
.05	.09041	.31345		.26740	
.10	.11737	.33520		.27641	
.15	.14433	.35198		.28171	
.20	.17130	.36352		.28356	
.25	.19826	.36956		.28205	
.30	.22522	.36994		.27712	
.35	.25218	.36454		.26853	
.40	.27915	.35333		.25588	
.45	.30611	.33638		.23862	
.50	.33307	.31380		.21635	
.55	.36003	.28580		.18919	
.60	.38700	.25263		.15772	
.65	.41396	.21458		.12258	
.70	.44092	.17199		.08423	
.75	.46788	.12529		.04304	
.80	.49485	.07491		-.00073	
.85	.52181	.02135		-.04690	
.90	.54877	-.03502		-.09530	
.95	.57573	-.09380		-.14581	
.98	.59191	-.13008		-.17709	-.16673
.99	.59730	-.14232		-.18767	-.16563
1.00	.60270	-.15464	-.15674	-.19834	-.15674
LE Center	(.07971,	.28052)	R = .01626		
TE Center	(.59267,	-.15674)	R = .01002		
Center of Gravity	(.33241,	.20643)			
Radial Reference	(.31261,	.17488)			
Gaging =	.23332				
Nose Point	(.06686,	.27055)			
Tail Point	(.59695,	-.16580)			
LE Tangency Points	Top	(.06796,	.29176) Bottom	(.08606,	.26555)
TE Tangency Points	Top	(.60186,	-.15272) Bottom	(.58377,	-.16134)
Inlet Angle =	55.35787				
Exit Angle =	25.49415				
No. of Blades =	126				
Pitch =	.54049				
Tolerance =	-.00000				
Gaging =	.23332				
Uncovered Turning =	12.34394				
Gaging Angle =	25.57425				
Area =	.04196				
Axial Chord =	.53925				

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TABLE XXXII
2ND STAGE BLADE

Section E-E		ATR = 11.51000				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)	
.00	.07605	.33627	.32878	.30786	.32878	
.01	.08121	.34041	.34036	.30961	.31721	
.02	.08637	.34444		.31122	.31413	
.03	.09153	.34836		.31268	.31322	
.04	.09669	.35217		.31401		
.05	.10184	.35585		.31520		
.10	.12764	.37233		.31922		
.15	.15343	.38512		.32007		
.20	.17922	.39368		.31781		
.25	.20502	.39746		.31233		
.30	.23081	.39598		.30340		
.35	.25660	.38879		.29059		
.40	.28239	.37559		.27333		
.45	.30819	.35622		.25115		
.50	.33398	.33073		.22398		
.55	.35977	.29933		.19231		
.60	.38557	.26241		.15685		
.65	.41136	.22048		.11820		
.70	.43715	.17406		.07675		
.75	.46294	.12369		.03278		
.80	.48874	.06982		-.01354		
.85	.51453	.01286		-.06208		
.90	.54032	-.04685		-.11271		
.95	.56612	-.10898		-.16535		
.98	.58159	-.14730		-.19787	-.18518	
.99	.58675	-.16024		-.20886	-.18393	
1.00	.59191	-.17325	-.17517	-.21992	-.17517	
LE Center	(.09162,	.32878)	R = .01557			
TE Center	(.58189,	-.17517)	R = .01002			
Center of Gravity	(.34076,	.21272)				
Radial Reference	(.31261,	.17488)				
Gaging =	.22895					
Nose Point	(.07798,	.32128)				
Tail Point	(.58585,	-.18437)				
LE Tangency Points	Top	(.08203,	.34105)	Bottom	(.09550,	.31371)
TE Tangency Points	Top	(.59120,	-.17147)	Bottom	(.57284,	-.17947)
Inlet Angle =	63.77058					
Exit Angle =	23.53731					
No. of Blades =	126					
Pitch =	.57396					
Tolerance =	-.00000					
Gaging =	.22895					
Uncovered Turning =	11.95900					
Gaging Angle =	23.50865					
Area =	.04204					
Axial Chord =	.51586					

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TABLE XXXIII
2ND STAGE BLADE

Section F-F		AT R = 7.46000			
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)
.00	.00000	.10463	.09779	.05435	.09779
.01	.00657	.11311		.06059	.08298
.02	.01314	.12128		.06650	.07902
.03	.01971	.12915		.07210	.07781
.04	.02628	.13674		.07742	.07883
.05	.03285	.14405		.08248	
.10	.06570	.17680		.10438	
.15	.09855	.20385		.12161	
.20	.13140	.22586		.13507	
.25	.16425	.24329		.14531	
.30	.19710	.25645		.15272	
.35	.22995	.26558		.15752	
.40	.26280	.27080		.15990	
.45	.29565	.27218		.15993	
.50	.32850	.26974		.15768	
.55	.36135	.26343		.15314	
.60	.39420	.25311		.14626	
.65	.42705	.23860		.13695	
.70	.45990	.21961		.12504	
.75	.49275	.19570		.11029	
.80	.52560	.16632		.09232	
.85	.55845	.13131		.07057	
.90	.59130	.09157		.04413	
.95	.62415	.04844		.01143	
.98	.64386	.02143		-.01239	-.00983
.99	.65043	.01228		-.02128	-.00964
1.00	.65700	.00307	-.00017	-.03075	-.00017
LE Center	(.01998,	.09779)	R = .01998		
TE Center	(.64688,	-.00017)	R = .01012		
Center of Gravity	(.31263,	.17484)			
Radial Reference	(.31261,	.17488)			
Gaging =	.22381				
Nose Point	(.09637,	.08317)			
Tail Point	(.65283,	-.00835)			
LE Tangency Points	Top	(.00419,	.11003) Bottom	(.03218,	.08196)
TE Tangency Points	Top	(.65512,	.00571) Bottom	(.63908,	-.00662)
Inlet Angle =	45.08702				
Exit Angle =	37.54949				
No. of Blades =	126				
Pitch =	.37200				
Tolerance =	-.00000				
Gaging =	.22381				
Uncovered Turning =	14.88048				
Gaging Angle =	36.98783				
Area =	.05564				
Axial Chord =	.65700				

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TABLE XXXIV
2ND STAGE BLADE

SECTION G-G		AT R = 11.96500				
Percent X	X	Y (Top)	(Circle)	Y (Bot)	(Circle)	
.00	.08460	.37280	.36441	.34706	.36441	
.01	.08960	.37591	.37560	.34792	.35323	
.02	.09460	.37893		.34867	.35026	
.03	.09960	.38187		.34931	.34939	
.04	.10460	.38472		.34983		
.05	.10960	.38749		.35024		
.10	.13460	.39981		.35059		
.15	.15960	.40929		.34813		
.20	.18460	.41535		.34275		
.25	.20960	.41734		.33424		
.30	.23460	.41456		.32222		
.35	.25960	.40633		.30613		
.40	.28460	.39207		.28532		
.45	.30960	.37141		.25947		
.50	.33460	.34426		.22898		
.55	.35960	.31082		.19451		
.60	.38460	.27156		.15666		
.65	.40960	.22710		.11585		
.70	.43460	.17805		.07240		
.75	.45960	.12498		.02655		
.80	.48460	.06840		-.02154		
.85	.50960	.00875		-.07172		
.90	.53460	-.05359		-.12389		
.95	.55960	-.11829		-.17796		
.98	.57460	-.15811		-.21130	-.19686	
.99	.57960	-.17154		-.22255	-.19551	
1.00	.58460	-.18505	-.18684	-.23388	-.18684	
LE Center	(.09962,	.36441)	R = .01502			
TE Center	(.57458,	-.18684)	R = .01002			
Center of Gravity	(.34632,	.21697)				
Radial Reference	(.31261,	.17488)				
Gaging =	.22417					
Nose Point	(.08558,	.35907)				
Tail Point	(.57834,	-.19613)				
LE Tangency Points	Top	(.09184,	.37727)	Bottom	(.10117,	.34948)
TE Tangency Points	Top	(.58397,	-.18336)	Bottom	(.56544,	-.19095)
Inlet Angle =	71.43985					
Exit Angle =	22.27146					
No. of Blades =	126					
Pitch =	.59665					
Tolerance =	-.00000					
Gaging =	.22417					
Uncovered Turning =	11.69901					
Gaging Angle =	22.06786					
Area =	.04245					
Axial Chord =	.50000					

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TABLE XXXV

FIRST VANE CASCADE TURNING VANE

Radius of Root Section = 7.5750
Pitch = 2.0480

Axial Chord = 3.5000
No. of Foils = 4

Actual Chord = 3.5925

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	0.8710	0.8460
0.01	0.0350	0.8710	0.8710
0.02	0.0700	0.8709	0.8709
0.03	0.1050	0.8707	0.8707
0.04	0.1400	0.8705	0.8705
0.05	0.1750	0.8701	0.8701
0.10	0.3500	0.8670	0.8670
0.15	0.5250	0.8612	0.8612
0.20	0.7000	0.8526	0.8526
0.25	0.8750	0.8407	0.8407
0.30	1.0500	0.8253	0.8253
0.35	1.2250	0.8060	0.8060
0.40	1.4000	0.7823	0.7823
0.45	1.5750	0.7539	0.7539
0.50	1.7500	0.7205	0.7205
0.55	1.9250	0.6814	0.6814
0.60	2.1000	0.6365	0.6365
0.65	2.2750	0.5854	0.5854
0.70	2.4500	0.5277	0.5277
0.75	2.6250	0.4634	0.4634
0.80	2.8000	0.3922	0.3922
0.85	2.9750	0.3141	0.3141
0.90	3.1500	0.2293	0.2293
0.95	3.3250	0.1377	0.1377
0.98	3.4300	0.0795	0.0795
0.99	3.4650	0.0595	0.0595
1.00	3.5000	0.0394	0.0249
Foil L.E. Circle	X = 0.0250,	Y = 0.8460,	R = 0.0250
Foil T.E. Circle	X = 3.4750,	Y = 0.0249,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0251,	Y = 0.8710	
Foil L.E. Tangency Pt. (Bot)	X = 0.0500,	Y = 0.8460	
Foil T.E. Tangency Pt. (Top)	X = 3.4874,	Y = 0.0466	
Foil T.E. Tangency Pt. (Bot)	X = 3.4626,	Y = 0.0033	
Foil Nose Point	X = 0.0007,	Y = 0.8399	
Foil Tail Point	X = 3.4967,	Y = 0.0125	
Foil Area (Less Core) = 0.1745			
Gaging Gaging Angle	LAMBDA = 1.7859, = 60.695	X = 2.7715,	Y = 0.4043
Center of Gravity Radial Reference	X = 1.7929, X = 1.7929,	Y = 0.5946 Y = 0.5946	
Inlet Angle	= 90.		
Exit Angle	= 59.98		
Uncovered Turning	= 7.029		

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TABLE XXXVI

FIRST VANE CASCADE TURNING VANE

Radius of 1/4R Section = 8.0930
Pitch = 2.1880

Axial Chord = 3.5000
No. of Foils = 4

Actual Chord = 3.6020

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	0.9125	0.8875
0.01	0.0350	0.9125	0.9125
0.02	0.0700	0.9124	0.9124
0.03	0.1050	0.9123	0.9123
0.04	0.1400	0.9121	0.9121
0.05	0.1750	0.9119	0.9119
0.10	0.3500	0.9094	0.9094
0.15	0.5250	0.9046	0.9046
0.20	0.7000	0.8974	0.8974
0.25	0.8750	0.8872	0.8872
0.30	1.0500	0.8735	0.8735
0.35	1.2250	0.8559	0.8559
0.40	1.4000	0.8336	0.8336
0.45	1.5750	0.8061	0.8061
0.50	1.7500	0.7727	0.7727
0.55	1.9250	0.7327	0.7327
0.60	2.1000	0.6855	0.6855
0.65	2.2750	0.6307	0.6307
0.70	2.4500	0.5680	0.5680
0.75	2.6250	0.4975	0.4975
0.80	2.8000	0.4193	0.4193
0.85	2.9750	0.3340	0.3340
0.90	3.1500	0.2418	0.2418
0.95	3.3250	0.1433	0.1433
0.98	3.4300	0.0814	0.0814
0.99	3.4650	0.0603	0.0603
1.00	3.5000	0.0390	0.0252
Foil L.E. Circle	X = 0.0250,	Y = 0.8875,	R = 0.0250
Foil T.E. Circle	X = 3.4755,	Y = 0.0252,	R = 0.0245
Foil L.E. Tangency Pt. (Top)	X = 0.0251,	Y = 0.9125	
Foil L.E. Tangency Pt. (Bot)	X = 0.0500,	Y = 0.8875	
Foil T.E. Tangency Pt. (Top)	X = 3.4882,	Y = 0.0461	
Foil T.E. Tangency Pt. (Bot)	X = 3.4623,	Y = 0.0045	
Foil Nose Point	X = 0.0007,	Y = 0.8814	
Foil Tail Point	X = 3.4963,	Y = 0.0122	
Foil Area (Less Core) = 0.1722			
Gaging Gaging Angle	LAMBDA = 1.8880, = 59.643	X = 2.6987,	Y = 0.4655
Center of Gravity Radial Reference	X = 1.7832, X = 1.7929,	Y = 0.6371 Y = 0.5946	
Inlet Angle	= 90.		
Exit Angle	= 58.62		
Uncovered Turning	= 7.288		

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TABLE XXXVII

FIRST VANE CASCADE TURNING VANE

Radius of Mean Section = 8.6125
Pitch = 2.3285

Axial Chord = 3.5000
No. of Foils = 4

Actual Chord = 3.6151

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	0.9539	0.9289
0.01	0.0350	0.9539	0.9518
0.02	0.0700	0.9539	0.9539
0.03	0.1050	0.9538	0.9538
0.04	0.1400	0.9537	0.9537
0.05	0.1750	0.9535	0.9535
0.10	0.3500	0.9519	0.9519
0.15	0.5250	0.9489	0.9489
0.20	0.7000	0.9440	0.9440
0.25	0.8750	0.9369	0.9369
0.30	1.0500	0.9269	0.9269
0.35	1.2250	0.9135	0.9135
0.40	1.4000	0.8955	0.8955
0.45	1.5750	0.8720	0.8720
0.50	1.7500	0.8417	0.8417
0.55	1.9250	0.8031	0.8031
0.60	2.1000	0.7549	0.7549
0.65	2.2750	0.6964	0.6964
0.70	2.4500	0.6274	0.6274
0.75	2.6250	0.5482	0.5482
0.80	2.8000	0.4600	0.4600
0.85	2.9750	0.3639	0.3639
0.90	3.1500	0.2610	0.2610
0.95	3.3250	0.1522	0.1522
0.98	3.4300	0.0845	0.0845
0.99	3.4650	0.0615	0.0615
1.00	3.5000	0.0384	0.0250
Foil L.E. Circle	X = 0.0250	Y = 0.9289	R = 0.0250
Foil T.E. Circle	X = 3.4751	Y = 0.0250	R = 0.0249
Foil L.E. Tangency Pt. (Top)	X = 0.0500	Y = 0.9289	
Foil L.E. Tangency Pt. (Bot)	X = 0.0239	Y = 0.9039	
Foil T.E. Tangency Pt. (Top)	X = 3.4888	Y = 0.0458	
Foil T.E. Tangency Pt. (Bot)	X = 3.4613	Y = 0.0042	
Foil Nose Point	X = 0.0007	Y = 0.9350	
Foil Tail Point	X = 3.4959	Y = 0.0112	
Foil Area (Less Core)	0.1775		
Gaging	LAMBDA = 1.9704	X = 2.6151	Y = 0.5529
Gaging Angle	= 57.805		
Center of Gravity	X = 1.8051	Y = 0.6794	
Radial Reference	X = 1.7929	Y = 0.5946	
Inlet Angle	= 90.00		
Exit Angle	= 56.521		
Uncovered Turning	= 7.897		

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TABLE XXXVIII

FIRST VANE CASCADE TURNING VANE

Radius of 1/4T Section = 9.1312
Pitch = 2.4687

Axial Chord = 3.5000
No. of Foils = 4

Actual Chord = 3.6266

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	0.9977	0.9727
0.01	0.0350	0.9977	0.9956
0.02	0.0700	0.9977	0.9977
0.03	0.1050	0.9976	0.9976
0.04	0.1400	0.9974	0.9974
0.05	0.1750	0.9972	0.9972
0.10	0.3500	0.9951	0.9951
0.15	0.5250	0.9910	0.9910
0.20	0.7000	0.9846	0.9846
0.25	0.8750	0.9753	0.9753
0.30	1.0500	0.9626	0.9626
0.35	1.2250	0.9456	0.9456
0.40	1.4000	0.9235	0.9235
0.45	1.5750	0.8953	0.8953
0.50	1.7500	0.8599	0.8599
0.55	1.9250	0.8162	0.8162
0.60	2.1000	0.7634	0.7634
0.65	2.2750	0.7012	0.7012
0.70	2.4500	0.6294	0.6294
0.75	2.6250	0.5487	0.5487
0.80	2.8000	0.4597	0.4597
0.85	2.9750	0.3635	0.3635
0.90	3.1500	0.2607	0.2607
0.95	3.3250	0.1521	0.1521
0.98	3.4300	0.0845	0.0845
0.99	3.4650	0.0616	0.0616
1.00	3.5000	0.0385	0.0250
Foil L.E. Circle	X = 0.0250	Y = 0.9727	R = 0.0250
Foil T.E. Circle	X = 3.4750	Y = 0.0250	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0500	Y = 0.9727	
Foil L.E. Tangency Pt. (Bot)	X = 0.0263	Y = 0.9478	
Foil T.E. Tangency Pt. (Top)	X = 3.4887	Y = 0.0459	
Foil T.E. Tangency Pt. (Bot)	X = 3.4612	Y = 0.0042	
Foil Nose Point	X = 0.0007	Y = 0.9787	
Foil Tail Point	X = 3.4959	Y = 0.0113	
Foil Area (Less core) = 0.1723			
Gaging	LAMBDA = 2.0965	X = 2.5710	Y = 0.5745
Gaging Angle	= 58.128		
Center of Gravity	X = 1.8227	Y = 0.6918	
Radial Reference	X = 1.7929	Y = 0.5946	
Inlet Angle	= 90.00		
Exit Angle	= 56.527		
Uncovered Turning	= 8.114		

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TABLE XXXIX

FIRST VANE CASCADE TURNING VANE

Radius of Tip Section = 9.6500
Pitch = 2.6090

Axial Chord = 3.5000
No. of Foils = 4

Actual Chord = 3.6378

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	1.0415	1.0165
0.01	0.0350	1.0414	1.0414
0.02	0.0700	1.0410	1.0410
0.03	0.1050	1.0408	1.0408
0.04	0.1400	1.0407	1.0407
0.05	0.1750	1.0406	1.0406
0.10	0.3500	1.0369	1.0369
0.15	0.5250	1.0301	1.0301
0.20	0.7000	1.0197	1.0197
0.25	0.8750	1.0051	1.0051
0.30	1.0500	0.9860	0.9860
0.35	1.2250	0.9616	0.9616
0.40	1.4000	0.9314	0.9314
0.45	1.5750	0.8950	0.8950
0.50	1.7500	0.8517	0.8517
0.55	1.9250	0.8013	0.8013
0.60	2.1000	0.7436	0.7436
0.65	2.2750	0.6784	0.6784
0.70	2.4500	0.6059	0.6059
0.75	2.6250	0.5260	0.5260
0.80	2.8000	0.4404	0.4404
0.85	2.9750	0.3482	0.3482
0.90	3.1500	0.2503	0.2503
0.95	3.3250	0.1470	0.1470
0.98	3.4300	0.0826	0.0826
0.99	3.4650	0.0608	0.0608
1.00	3.5000	0.0388	0.0247
Foil L.E. Circle	X = 0.0250	Y = 1.0165	R = 0.0250
Foil L.E. Circle	X = 3.4746	Y = 0.0247	R = 0.0254
Foil L.E. Tangency Pt. (Top)	X = 0.0253	Y = 1.0415	
Foil L.E. Tangency Pt. (Bot)	X = 0.0242	Y = 0.9915	
Foil T.E. Tangency Pt. (Top)	X = 3.4881	Y = 0.0463	
Foil T.E. Tangency Pt. (Bot)	X = 3.4614	Y = 0.0030	
Foil Nose Point	X = -0.0000	Y = 1.0165	
Foil Tail Point	X = 3.4962	Y = 0.0114	
Foil Area (Less Core) = 0.1835			
Gaging Gaging Angle	LAMBDA = 2.2440 = 59.330	X = 2.5322	Y = 0.5692
Center of Gravity Radial Reference	X = 1.7997 X = 1.7929	Y = 0.7008 Y = 0.5946	
Inlet Angle	= 90.00		
Exit Angle	= 57.79		
Uncovered Turning	= 7.497		

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TABLE XL
FIRST BLADE CASCADE TURNING VANE

Radius of Root Section = 7.5375
Pitch = 1.0867

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.5894

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.3284	-1.3034
0.01	0.0225	-1.3284	-1.3283
0.02	0.0450	-1.3282	-1.3282
0.03	0.0675	-1.3278	-1.3278
0.04	0.0900	-1.3270	-1.3270
0.05	0.1125	-1.3260	-1.3260
0.10	0.2250	-1.3161	-1.3161
0.15	0.3375	-1.2993	-1.2993
0.20	0.4500	-1.2757	-1.2757
0.25	0.5625	-1.2458	-1.2458
0.30	0.6750	-1.2098	-1.2098
0.35	0.7875	-1.1679	-1.1679
0.40	0.9000	-1.1200	-1.1200
0.45	1.0125	-1.0663	-1.0663
0.50	1.1250	-1.0068	-1.0068
0.55	1.2375	-0.9414	-0.9414
0.60	1.3500	-0.8699	-0.8699
0.65	1.4625	-0.7921	-0.7921
0.70	1.5750	-0.7077	-0.7077
0.75	1.6875	-0.6164	-0.6164
0.80	1.8000	-0.5176	-0.5176
0.85	1.9125	-0.4107	-0.4107
0.90	2.0250	-0.2950	-0.2950
0.95	2.1375	-0.1696	-0.1696
0.98	2.2050	-0.0896	-0.0896
0.99	2.2275	-0.0620	-0.0620
1.00	2.2500	-0.0337	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.3034,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.3284	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.2784	
Foil T.E. Tangency Pt. (Top)	X = 2.2445,	Y = -0.0405	
Foil T.E. Tangency Pt. (Bot)	X = 2.2055,	Y = -0.0094	
Foil Nose Point	X = 0.0,	Y = -1.3034	
Foil Tail Point	X = 2.2406,	Y = -0.0054	
Foil Area (Less Core) = 0.1337			
Gaging	LAMBDA = 0.7011,	X = 1.7450,	Y = -0.5669
Gaging Angle	= 40.179		
Center of Gravity	X = 1.2058,	Y = -0.8246	
Radial Reference	X = 1.2058,	Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 38.618		
Uncovered Turning	= 10.100		
Constant Section Thickness = .050			

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TABLE XLI
FIRST BLADE CASCADE TURNING VANE

Radius of 1/BR Section = 7.8591
Pitch = 1.1331

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.5722

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.2936	-1.2686
0.01	0.0225	-1.2936	-1.2935
0.02	0.0450	-1.2935	-1.2935
0.03	0.0675	-1.2931	-1.2931
0.04	0.0900	-1.2924	-1.2924
0.05	0.1125	-1.2915	-1.2915
0.10	0.2250	-1.2829	-1.2829
0.15	0.3375	-1.2678	-1.2678
0.20	0.4500	-1.2464	-1.2464
0.25	0.5625	-1.2190	-1.2190
0.30	0.6750	-1.1855	-1.1855
0.35	0.7875	-1.1461	-1.1461
0.40	0.9000	-1.1009	-1.1009
0.45	1.0125	-1.0497	-1.0497
0.50	1.1250	-0.9926	-0.9926
0.55	1.2375	-0.9294	-0.9294
0.60	1.3500	-0.8600	-0.8600
0.65	1.4625	-0.7841	-0.7841
0.70	1.5750	-0.7013	-0.7013
0.75	1.6875	-0.6113	-0.6113
0.80	1.8000	-0.5135	-0.5135
0.85	1.9125	-0.4074	-0.4074
0.90	2.0250	-0.2923	-0.2923
0.95	2.1375	-0.1679	-0.1679
0.98	2.2050	-0.0842	-0.0842
0.99	2.2275	-0.0522	-0.0522
1.00	2.2500	-0.0339	-0.0250
Foil L.E. Circle	X = 0.0250	Y = -1.2686	R = 0.0250
Foil T.E. Circle	X = 2.2250	Y = -0.0250	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250	Y = -1.2936	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250	Y = -1.2436	
Foil T.E. Tangency Pt. (Top)	X = 2.2444	Y = -0.0408	
Foil T.E. Tangency Pt. (Bot)	X = 2.2056	Y = 0.0092	
Foil Nose Point	X = 0.0	Y = -1.2686	
Foil Tail Point	X = 2.2408	Y = -0.0056	
Foil Area (Less Core) = 0.1299			
Gaging	LAMBDA = 0.7396	X = 1.7273	Y = -0.5776
Gaging Angle	= 40.747		
Center of Gravity	X = 1.2032	Y = -0.8107	
Radial Reference	X = 1.2058	Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 39.088		
Uncovered Turning	= 10.268		
Constant Section Thickness = .050			

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TABLE XLII
FIRST BLADE CASCADE TURNING VANE

Radius of 1/4R Section = 8.1806
Pitch = 1.1794

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.5554

Percent X	Foil	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.2589	-1.2339
0.01	0.0225	-1.2589	-1.2588
0.02	0.0450	-1.2588	-1.2588
0.03	0.0675	-1.2585	-1.2585
0.04	0.0900	-1.2579	-1.2579
0.05	0.1125	-1.2572	-1.2572
0.10	0.2250	-1.2499	-1.2499
0.15	0.3375	-1.2369	-1.2369
0.20	0.4500	-1.2181	-1.2181
0.25	0.5625	-1.1936	-1.1936
0.30	0.6750	-1.1633	-1.1633
0.35	0.7875	-1.1270	-1.1270
0.40	0.9000	-1.0848	-1.0848
0.45	1.0125	-1.0363	-1.0363
0.50	1.1250	-0.9817	-0.9817
0.55	1.2375	-0.9205	-0.9205
0.60	1.3500	-0.8527	-0.8527
0.65	1.4625	-0.7780	-0.7780
0.70	1.5750	-0.6960	-0.6960
0.75	1.6875	-0.6066	-0.6066
0.80	1.8000	-0.5092	-0.5092
0.85	1.9125	-0.4035	-0.4035
0.90	2.0250	-0.2892	-0.2892
0.95	2.1375	-0.1660	-0.1660
0.98	2.2050	-0.0828	-0.0828
0.99	2.2275	-0.0554	-0.0554
1.00	2.2500	-0.0340	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.2339,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.2589	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.2089	
Foil T.E. Tangency Pt. (Top)	X = 2.2443,	Y = -0.0409	
Foil T.E. Tangency Pt. (Bot)	X = 2.2057,	Y = -0.0091	
Foil Nose Point	X = 0.0,	Y = -1.2339	
Foil Tail Point	X = 2.2409,	Y = -0.0057	
Foil Area (Less Core) = 0.1292			
Gaging	LAMBDA = 0.7784,	X = 1.7079,	Y = -0.5895
Gaging Angle	= 41.299		
Center of Gravity	X = 1.2074,	Y = -0.7949	
Radial Reference	X = 1.2058,	Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 39.608		
Uncovered Turning	= 10.281		
Constant Section Thickness = .050			

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TABLE XLIII
FIRST BLADE CASCADE TURNING VANE

Radius of 3/8R Section = 8.5022
Pitch = 1.2258

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.5391

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.2243	-1.1993
0.01	0.0225	-1.2243	-1.2241
0.02	0.0450	-1.2242	-1.2242
0.03	0.0675	-1.2239	-1.2239
0.04	0.0900	-1.2235	-1.2235
0.05	0.1125	-1.2229	-1.2229
0.10	0.2250	-1.2170	-1.2170
0.15	0.3375	-1.2063	-1.2063
0.20	0.4500	-1.1904	-1.1904
0.25	0.5625	-1.1692	-1.1692
0.30	0.6750	-1.1424	-1.1424
0.35	0.7875	-1.1097	-1.1097
0.40	0.9000	-1.0708	-1.0708
0.45	1.0125	-1.0253	-1.0253
0.50	1.1250	-0.9732	-0.9732
0.55	1.2375	-0.9139	-0.9139
0.60	1.3500	-0.8474	-0.8474
0.65	1.4625	-0.7734	-0.7734
0.70	1.5750	-0.6918	-0.6918
0.75	1.6875	-0.6023	-0.6023
0.80	1.8000	-0.5049	-0.5049
0.85	1.9125	-0.3995	-0.3995
0.90	2.0250	-0.2859	-0.2859
0.95	2.1375	-0.1641	-0.1641
0.98	2.2050	-0.0843	-0.0843
0.99	2.2275	-0.0535	-0.0535
1.00	2.2500	-0.0341	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.1993,	Y = -0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	Y = -0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.2243	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.1743	
Foil T.E. Tangency Pt. (Top)	X = 2.2441,	Y = -0.0411	
Foil T.E. Tangency Pt. (Bot)	X = 2.2059,	Y = -0.0089	
Foil Nose Point	X = 0.0,	Y = 1.1993	
Foil Tail Point	X = 2.2411,	Y = -0.0058	
a (Less Core) = 0.1307			
Gaging	LAMBDA = 0.8173,	X = 1.6870,	Y = -0.6027
Gaging Angle	= 41.814		
Center of Gravity	X = 1.2137,	Y = -0.7801	
Radial Reference	X = 1.2058,	Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 40.109		
Uncovered Turning	= 10.214		
Constant Section Thickness = .050			

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TABLE XLIV
FIRST BLADE CASCADE TURNING VANE

Radius of Mean Section = 8.8237
Pitch = 1.2722

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.5230

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.1896	-1.1646
0.01	0.0225	-1.1896	-1.1895
0.02	0.0450	-1.1895	-1.1895
0.03	0.0675	-1.1893	-1.1893
0.04	0.0900	-1.1890	-1.1890
0.05	0.1125	-1.1885	-1.1885
0.10	0.2250	-1.1838	-1.1838
0.15	0.3375	-1.1749	-1.1749
0.20	0.4500	-1.1616	-1.1616
0.25	0.5625	-1.1433	-1.1433
0.30	0.6750	-1.1197	-1.1197
0.35	0.7875	-1.0903	-1.0903
0.40	0.9000	-1.0547	-1.0547
0.45	1.0125	-1.0123	-1.0123
0.50	1.1250	-0.9630	-0.9630
0.55	1.2375	-0.9061	-0.9061
0.60	1.3500	-0.8415	-0.8415
0.65	1.4625	-0.7690	-0.7690
0.70	1.5750	-0.6882	-0.6882
0.75	1.6875	-0.5994	-0.5994
0.80	1.8000	-0.5023	-0.5023
0.85	1.9125	-0.3973	-0.3973
0.90	2.0250	-0.2841	-0.2841
0.95	2.1375	-0.1631	-0.1631
0.98	2.2050	-0.0853	-0.0853
0.99	2.2275	-0.0605	-0.0605
1.00	2.2500	-0.0341	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.1646,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.1896	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.1396	
Foil T.E. Tangency Pt. (Top)	X = 2.2441,	Y = -0.0411	
Foil T.E. Tangency Pt. (Bot)	X = 2.2060,	Y = -0.0088	
Foil Nose Point	X = 0.0,	Y = -1.1646	
Foil Tail Point	X = 2.2412,	Y = -0.0059	
Foil Area (Less Core) = 0.1331			
Gaging	LAMBDA = 0.8554,	X = 1.6690,	Y = -0.6145
Gaging Angle	= 42.250		
Center of Gravity	X = 1.2171,	Y = -0.7663	
Radial Reference	X = 1.2058,	Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 40.381		
Uncovered Turning	= 10.494		
Constant Section Thickness = .050			

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TABLE XLV

FIRST BLADE CASCADE TURNING VANE

Radius of 1/8T Section = 9.1453
Pitch = 1.3185

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.5072

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.1548	-1.1298
0.01	0.0225	-1.1548	-1.1547
0.02	0.0450	-1.1548	-1.1548
0.03	0.0675	-1.1546	-1.1546
0.04	0.0900	-1.1543	-1.1543
0.05	0.1125	-1.1539	-1.1539
0.10	0.2250	-1.1497	-1.1497
0.15	0.3375	-1.1418	-1.1418
0.20	0.4500	-1.1298	-1.1298
0.25	0.5625	-1.1132	-1.1132
0.30	0.6750	-1.0917	-1.0917
0.35	0.7875	-1.0647	-1.0647
0.40	0.9000	-1.0318	-1.0318
0.45	1.0125	-0.9924	-0.9924
0.50	1.1250	-0.9462	-0.9462
0.55	1.2375	-0.8925	-0.8925
0.60	1.3500	-0.8311	-0.8311
0.65	1.4625	-0.7616	-0.7616
0.70	1.5750	-0.6836	-0.6836
0.75	1.6875	-0.5969	-0.5969
0.80	1.8000	-0.5013	-0.5013
0.85	1.9125	-0.3970	-0.3970
0.90	2.0250	-0.2841	-0.2841
0.95	2.1375	-0.1630	-0.1630
0.98	2.2050	-0.0847	-0.0847
0.99	2.2275	-0.0583	-0.0583
1.00	2.2500	-0.0342	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.1298,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.1548	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.1048	
Foil T.E. Tangency Pt. (Top)	X = 2.2440,	Y = -0.0412	
Foil T.E. Tangency Pt. (Bot)	X = 2.2060,	Y = -0.0088	
Foil Nose Point	X = 0.0,	Y = -1.1298	
Foil Tail Point	X = 2.2412,	Y = -0.0060	
Foil Area (Less Core) = 0.1344			
Gaging Gaging Angle	LAMBDA = 0.8939, = 42.683	X = 1.6566,	Y = -0.6216
Center of Gravity Radial Reference	X = 1.2099, X = 1.2058,	Y = -0.7545 Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 40.399		
Uncovered Turning	= 11.389		
Constant Section Thickness = .050			

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TABLE XLVI
FIRST BLADE CASCADE TURNING VANE

Radius of 1/4T Section = 9.4668
Pitch = 1.3649

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4920

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.1203	-1.0953
0.01	0.0225	-1.1203	-1.1202
0.02	0.0450	-1.1202	-1.1202
0.03	0.0675	-1.1201	-1.1201
0.04	0.0900	-1.1198	-1.1198
0.05	0.1125	-1.1193	-1.1193
0.10	0.2250	-1.1150	-1.1150
0.15	0.3375	-1.1069	-1.1069
0.20	0.4500	-1.0948	-1.0948
0.25	0.5625	-1.0783	-1.0783
0.30	0.6750	-1.0572	-1.0572
0.35	0.7875	-1.0309	-1.0309
0.40	0.9000	-0.9992	-0.9992
0.45	1.0125	-0.9616	-0.9616
0.50	1.1250	-0.9176	-0.9176
0.55	1.2375	-0.8667	-0.8667
0.60	1.3500	-0.8085	-0.8085
0.65	1.4625	-0.7425	-0.7425
0.70	1.5750	-0.6682	-0.6682
0.75	1.6875	-0.5850	-0.5850
0.80	1.8000	-0.4927	-0.4927
0.85	1.9125	-0.3910	-0.3910
0.90	2.0250	-0.2803	-0.2803
0.95	2.1375	-0.1611	-0.1611
0.98	2.2050	-0.0818	-0.0818
0.99	2.2275	-0.0522	-0.0522
1.00	2.2500	-0.0344	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.0953,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.1203	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.0703	
Foil T.E. Tangency Pt. (Top)	X = 2.2439,	Y = -0.0414	
Foil T.E. Tangency Pt. (Bot)	X = 2.2061,	Y = -0.0086	
Foil Nose Point	X = 0.0,	Y = -1.0953	
Foil Tail Point	X = 2.2414,	Y = -0.0061	
Foil Area (Less Core) = 0.1341			
Gaging Gaging Angle	LAMBDA = 0.9409, = 43.579	X = 1.6463,	Y = -0.6165
Center of Gravity Radial Reference	X = 1.1980, X = 1.2058,	Y = -0.7380 Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 40.903		
Uncovered Turning	= 12.248		
Constant Section Thickness = .050			

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TABLE XLVII

FIRST BLADE CASCADE TURNING VANE

Radius of 3/8T Section = 9.7884
Pitch = 1.4113

Axial Chord = 2.2500
No. of Folds = 4

Actual Chord = 2.4776

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.0863	-1.0613
0.01	0.0225	-1.0863	-1.0861
0.02	0.0450	-1.0862	-1.0862
0.03	0.0675	-1.0860	-1.0860
0.04	0.0900	-1.0856	-1.0856
0.05	0.1125	-1.0850	-1.0850
0.10	0.2250	-1.0798	-1.0798
0.15	0.3375	-1.0704	-1.0704
0.20	0.4500	-1.0567	-1.0567
0.25	0.5625	-1.0385	-1.0385
0.30	0.6750	-1.0156	-1.0156
0.35	0.7875	-0.9879	-0.9879
0.40	0.9000	-0.9551	-0.9551
0.45	1.0125	-0.9169	-0.9169
0.50	1.1250	-0.8729	-0.8729
0.55	1.2375	-0.8229	-0.8229
0.60	1.3500	-0.7665	-0.7665
0.65	1.4625	-0.7031	-0.7031
0.70	1.5750	-0.6324	-0.6324
0.75	1.6875	-0.5538	-0.5538
0.80	1.8000	-0.4668	-0.4668
0.85	1.9125	-0.3712	-0.3712
0.90	2.0250	-0.2670	-0.2670
0.95	2.1375	-0.1546	-0.1546
0.98	2.2050	-0.0809	-0.0809
0.99	2.2275	-0.0535	-0.0535
1.00	2.2500	-0.0348	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.0613,	R = 0.0250
Foil T.E. Circle	X = 2.2249,	Y = -0.0250,	R = 0.0251
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.0863	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.0363	
Foil T.E. Tangency Pt. (Top)	X = 2.2434,	Y = -0.0420	
Foil T.E. Tangency Pt. (Bot)	X = 2.2064,	Y = -0.0080	
Foil Nose Point	X = 0.0,	Y = -1.0613	
Foil Tail Point	X = 2.2419,	Y = -0.0065	
Foil Area (Less Core) = 0.1325			
Gaging	LAMBDA = 1.0052,	X = 1.6341,	Y = -0.5921
Gaging Angle	= 45.419		
Center of Gravity	X = 1.1913,	Y = -0.7088	
Radial Reference	X = 1.2058,	Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 42.620		
Uncovered Turning	= 12.378		
Constant Section Thickness = .050			

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TABLE XLVIII
FIRST BLADE CASCADE TURNING VANE

Radius of Tip Section = 10.1100
Pitch = 1.4576

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4640

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-1.0528	-1.0278
0.01	0.0225	-1.0528	-1.0527
0.02	0.0450	-1.0527	-1.0527
0.03	0.0675	-1.0524	-1.0524
0.04	0.0900	-1.0519	-1.0519
0.05	0.1125	-1.0512	-1.0512
0.10	0.2250	-1.0444	-1.0444
0.15	0.3375	-1.0325	-1.0325
0.20	0.4500	-1.0155	-1.0155
0.25	0.5625	-0.9937	-0.9937
0.30	0.6750	-0.9669	-0.9669
0.35	0.7875	-0.9354	-0.9354
0.40	0.9000	-0.8990	-0.8990
0.45	1.0125	-0.8577	-0.8577
0.50	1.1250	-0.8115	-0.8115
0.55	1.2375	-0.7602	-0.7602
0.60	1.3500	-0.7038	-0.7038
0.65	1.4625	-0.6420	-0.6420
0.70	1.5750	-0.5746	-0.5746
0.75	1.6875	-0.5014	-0.5014
0.80	1.8000	-0.4219	-0.4219
0.85	1.9125	-0.3360	-0.3360
0.90	2.0250	-0.2431	-0.2431
0.95	2.1375	-0.1430	-0.1430
0.98	2.2050	-0.0794	-0.0794
0.99	2.2275	-0.0576	-0.0576
1.00	2.2500	-0.0355	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -1.0278,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -1.0528	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -1.0028	
Foil T.E. Tangency Pt. (Top)	X = 2.2426,	Y = -0.0428	
Foil T.E. Tangency Pt. (Bot)	X = 2.2075,	Y = -0.0073	
Foil Nose Point	X = 0.0,	Y = -1.0278	
Foil Tail Point	X = 2.2428,	Y = -0.0075	
Foil Area (Less Core) = 0.1293			
Gaging	LAMBDA = 1.0901,	X = 1.6200,	Y = -0.5460
Gaging Angle	= 48.403		
Center of Gravity	X = 1.1891,	Y = -0.6672	
Radial Reference	X = 1.2058,	Y = -0.8246	
Inlet Angle	= 90.000		
Exit Angle	= 45.388		
Uncovered Turning	= 11.766		
Constant Section Thickness = .050			

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TABLE XLIX

SECOND VANE CASCADE TURNING VANE

Radius of Root Section = 7.5000
Pitch = 1.5708

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.7443

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	1.9060	1.8810
0.01	0.0325	1.9060	1.9060
0.02	0.0650	1.9058	1.9058
0.03	0.0975	1.9052	1.9052
0.04	0.1300	1.9044	1.9044
0.05	0.1625	1.9032	1.9032
0.10	0.3250	1.8926	1.8926
0.15	0.4875	1.8737	1.8737
0.20	0.6500	1.8462	1.8462
0.25	0.8125	1.8098	1.8098
0.30	0.9750	1.7642	1.7642
0.35	1.1375	1.7091	1.7091
0.40	1.3000	1.6443	1.6443
0.45	1.4625	1.5694	1.5694
0.50	1.6250	1.4842	1.4842
0.55	1.7875	1.3885	1.3885
0.60	1.9500	1.2822	1.2822
0.65	2.1125	1.1649	1.1649
0.70	2.2750	1.0367	1.0367
0.75	2.4375	0.8975	0.8975
0.80	2.6000	0.7470	0.7470
0.85	2.7625	0.5854	0.5854
0.90	2.9250	0.4127	0.4127
0.95	3.0875	0.2289	0.2289
0.98	3.1850	0.1101	0.1101
0.99	3.2175	0.0725	0.0725
1.00	3.2500	0.0339	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 1.8810,	R = 0.0250
Foil T.E. Circle	X = 3.2250,	Y = 0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 1.9060	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 1.8560	
Foil T.E. Tangency Pt. (Top)	X = 3.2444,	Y = 0.0408	
Foil T.E. Tangency Pt. (Bot)	X = 3.2056,	Y = 0.0093	
Foil Nose Point	X = 0.0,	Y = 1.8810	
Foil Tail Point	X = 3.2407,	Y = 0.0056	
Foil Area (Less Core) = 0.1968			
Gaging	LAMBDA = 1.0214,	X = 2.5142,	Y = 0.8279
Gaging Angle	= 40.560		
Center of Gravity	X = 1.7484,	Y = 1.2099	
Radial Reference	X = 1.7484,	Y = 1.2099	
Inlet Angle	= 90.009		
Exit Angle	= 39.063		
Uncovered Turning	= 8.194		
Constant Section Thickness = .050			

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TABLE L
SECOND VANE CASCADE TURNING VANE

Radius of 1/8R Section = 7.8905
Pitch = 1.6526

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.6746

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	1.7623	1.7373
0.01	0.0325	1.7623	1.7623
0.02	0.0650	1.7621	1.7621
0.03	0.0975	1.7617	1.7617
0.04	0.1300	1.7611	1.7611
0.05	0.1625	1.7602	1.7602
0.10	0.3250	1.7521	1.7521
0.15	0.4875	1.7375	1.7375
0.20	0.6500	1.7157	1.7157
0.25	0.8125	1.6864	1.6864
0.30	0.9750	1.6489	1.6489
0.35	1.1375	1.6026	1.6026
0.40	1.3000	1.5469	1.5469
0.45	1.4625	1.4815	1.4815
0.50	1.6250	1.4056	1.4056
0.55	1.7875	1.3190	1.3190
0.60	1.9500	1.2212	1.2212
0.65	2.1125	1.1121	1.1121
0.70	2.2750	0.9915	0.9915
0.75	2.4375	0.8594	0.8594
0.80	2.6000	0.7161	0.7161
0.85	2.7625	0.5616	0.5616
0.90	2.9250	0.3963	0.3963
0.95	3.0875	0.2204	0.2204
0.98	3.1850	0.1096	0.1096
0.99	3.2175	0.0703	0.0703
1.00	3.2500	0.0342	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 1.7373,	R = 0.0250
Foil T.E. Circle	X = 3.2251,	Y = 0.0250,	R = 0.0249
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 1.7623	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 1.7123	
Foil T.E. Tangency Pt. (Top)	X = 3.2441,	Y = 0.0412	
Foil T.E. Tangency Pt. (Bot)	X = 3.2060,	Y = 0.0089	
Foil Nose Point	X = 0.0,	Y = 1.7373	
Foil Tail Point	X = 3.2412,	Y = 0.0060	
Foil Area (Less Core) = 0.1917			
Gaging	LAMBDA = 1.1088,	X = 2.4823,	Y = 0.8210
Gaging Angle	= 42.143		
Center of Gravity	X = 1.7482,	Y = 1.1345	
Radial Reference	X = 1.7484,	Y = 1.2099	
Inlet Angle	= 90.010		
Exit Angle	= 40.292		
Uncovered Turning	= 8.782		
Constant Section Thickness = .050			

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TABLE LI

SECOND VANE CASCADE TURNING VANE

Radius of 1/4R Section = 8.2810
Pitch = 1.7344

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.6127

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	1.6260	1.6010
0.01	0.0325	1.6260	1.6260
0.02	0.0650	1.6259	1.6259
0.03	0.0975	1.6255	1.6255
0.04	0.1300	1.6250	1.6250
0.05	0.1625	1.6243	1.6243
0.10	0.3250	1.6177	1.6177
0.15	0.4875	1.6055	1.6055
0.20	0.6500	1.5872	1.5872
0.25	0.8125	1.5621	1.5621
0.30	0.9750	1.5296	1.5296
0.35	1.1375	1.4891	1.4891
0.40	1.3000	1.4398	1.4398
0.45	1.4625	1.3812	1.3812
0.50	1.6250	1.3126	1.3126
0.55	1.7875	1.2336	1.2336
0.60	1.9500	1.1437	1.1437
0.65	2.1125	1.0428	1.0428
0.70	2.2750	0.9307	0.9307
0.75	2.4375	0.8074	0.8074
0.80	2.6000	0.6733	0.6733
0.85	2.7625	0.5286	0.5286
0.90	2.9250	0.3738	0.3738
0.95	3.0875	0.2090	0.2090
0.98	3.1850	0.1038	0.1038
0.99	3.2175	0.0671	0.0671
1.00	3.2500	0.0347	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 1.6010,	R = 0.0250
Foil T.E. Circle	X = 3.2250,	Y = 0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 1.6260	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 1.5760	
Foil T.E. Tangency Pt. (Top)	X = 3.2435,	Y = 0.0418	
Foil T.E. Tangency Pt. (Bot)	X = 3.2065,	Y = 0.0082	
Foil Nose Point	X = 0.0,	Y = 1.6010	
Foil Tail Point	X = 3.2418,	Y = 0.0065	
Foil Area (Less Core) = 0.1854			
Gaging Gaging Angle	LAMBDA = 1.2103, = 44.251	X = 2.4540,	Y = 0.7943
Center of Gravity Radial Reference	X = 1.7350, X = 1.7484,	Y = 1.0601 Y = 1.2099	
Inlet Angle	= 90.008		
Exit Angle	= 42.295		
Uncovered Turning	= 9.065		
Constant Section Thickness = .050			

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TABLE LII

SECOND VANE CASCADE TURNING VANE

Radius of 3/8R Section = 8.6715
Pitch = 1.8162

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.5566

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	1.4934	1.4684
0.01	0.0325	1.4933	1.4933
0.02	0.0650	1.4932	1.4932
0.03	0.0975	1.4929	1.4929
0.04	0.1300	1.4925	1.4925
0.05	0.1625	1.4918	1.4918
0.10	0.3250	1.4857	1.4857
0.15	0.4875	1.4745	1.4745
0.20	0.6500	1.4577	1.4577
0.25	0.8125	1.4347	1.4347
0.30	0.9750	1.4048	1.4048
0.35	1.1375	1.3676	1.3676
0.40	1.3000	1.3224	1.3224
0.45	1.4625	1.2686	1.2686
0.50	1.6250	1.2057	1.2057
0.55	1.7875	1.1332	1.1332
0.60	1.9500	1.0510	1.0510
0.65	2.1125	0.9585	0.9585
0.70	2.2750	0.8559	0.8559
0.75	2.4375	0.7431	0.7431
0.80	2.6000	0.6203	0.6203
0.85	2.7625	0.4877	0.4877
0.90	2.9250	0.3459	0.3459
0.95	3.0875	0.1950	0.1950
0.98	3.1850	0.1028	0.1028
0.99	3.2175	0.0674	0.0674
1.00	3.2500	0.0353	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 1.4684,	R = 0.0250
Foil T.E. Circle	X = 3.2250,	Y = 0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 1.4934	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 1.4434	
Foil T.E. Tangency Pt. (Top)	X = 3.2427,	Y = 0.0426	
Foil T.E. Tangency Pt. (Bot)	X = 3.2073,	Y = 0.0074	
Foil Nose Point	X = 0.0000,	Y = 1.4684	
Foil Tail Point	X = 3.2426,	Y = 0.0072	
Foil Area (Less Core) = 0.1790			
Gaging	LAMBDA = 1.3263,	X = 2.4329,	Y = 0.7464
Gaging Angle	= 46.908		
Center of Gravity	X = 1.7164,	Y = 0.9806	
Radial Reference	X = 1.7484,	Y = 1.2099	
Inlet Angle	= 90.081		
Exit Angle	= 44.835		
Uncovered Turning	= 9.241		
Constant Section Thickness = .050			

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TABLE LIII

SECOND VANE CASCADE TURNING VANE

Radius of Mean Section = 9.0625
Pitch = 1.8980

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.4991

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	1.3460	1.3210
0.01	0.0325	1.3460	1.3460
0.02	0.0650	1.3459	1.3459
0.03	0.0975	1.3456	1.3456
0.04	0.1300	1.3452	1.3452
0.05	0.1625	1.3446	1.3446
0.10	0.3250	1.3390	1.3390
0.15	0.4875	1.3287	1.3287
0.20	0.6500	1.3133	1.3133
0.25	0.8125	1.2924	1.2924
0.30	0.9750	1.2654	1.2654
0.35	1.1375	1.2319	1.2319
0.40	1.3000	1.1913	1.1913
0.45	1.4625	1.1431	1.1431
0.50	1.6250	1.0869	1.0869
0.55	1.7875	1.0223	1.0223
0.60	1.9500	0.9489	0.9489
0.65	2.1125	0.8665	0.8665
0.70	2.2750	0.7749	0.7749
0.75	2.4375	0.6741	0.6741
0.80	2.6000	0.5641	0.5641
0.85	2.7625	0.4451	0.4451
0.90	2.9250	0.3173	0.3173
0.95	3.0875	0.1809	0.1809
0.98	3.1850	0.0977	0.0977
0.99	3.2175	0.0752	0.0752
1.00	3.2500	0.0360	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 1.3210	R = 0.0250
Foil T.E. Circle	X = 3.2251,	Y = 0.0250,	R = 0.0249
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 1.3460	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 1.2960	
Foil T.E. Tangency Pt. (Top)	X = 3.2419,	Y = 0.0434	
Foil T.E. Tangency Pt. (Bot)	X = 3.2082,	Y = 0.0066	
Foil Nose Point	X = 0.0,	Y = 1.3210	
Foil Tail Point	X = 3.2434,	Y = 0.0082	
Foil Area (Less Core) = 0.1738			
Gaging	LAMBDA = 1.4515,	X = 2.4257,	Y = 0.6817
Gaging Angle	= 49.884		
Center of Gravity	X = 1.7002,	Y = 0.8902	
Radial Reference	X = 1.7484,	Y = 1.2099	
Inlet Angle	= 90.008		
Exit Angle	= 47.507		
Uncovered Turning	= 9.646		
Constant Section Thickness = .050			

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TABLE LIV

SECOND VANE CASCADE TURNING VANE

Radius of 1/8T Section = 9.4531
Pitch = 1.9799

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.4371

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	1.1693	1.1443
0.01	0.0325	1.1693	1.1693
0.02	0.0650	1.1692	1.1692
0.03	0.0975	1.1690	1.1690
0.04	0.1300	1.1687	1.1687
0.05	0.1625	1.1682	1.1682
0.10	0.3250	1.1638	1.1638
0.15	0.4875	1.1559	1.1559
0.20	0.6500	1.1437	1.1437
0.25	0.8125	1.1271	1.1271
0.30	0.9750	1.1055	1.1055
0.35	1.1375	1.0785	1.0785
0.40	1.3000	1.0456	1.0456
0.45	1.4625	1.0062	1.0062
0.50	1.6250	0.9598	0.9598
0.55	1.7875	0.9059	0.9059
0.60	1.9500	0.8441	0.8441
0.65	2.1125	0.7740	0.7740
0.70	2.2750	0.6954	0.6954
0.75	2.4375	0.6080	0.6080
0.80	2.6000	0.5117	0.5117
0.85	2.7625	0.4063	0.4063
0.90	2.9250	0.2919	0.2919
0.95	3.0875	0.1686	0.1686
0.98	3.1850	0.0923	0.0923
0.99	3.2175	0.0635	0.0635
1.00	3.2500	0.0367	0.0250
Foil L.E. Circle	X = 0.0249,	Y = 1.1443,	R = 0.0249
Foil T.E. Circle	X = 3.2250,	Y = 0.0250	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 1.1693	
Foil L.E. Tangency Pt. (Bot)	X = 0.0249,	Y = 1.1194	
Foil T.E. Tangency Pt. (Top)	X = 3.2410,	Y = 0.0442	
Foil T.E. Tangency Pt. (Bot)	X = 3.2090,	Y = 0.0059	
Foil Nose Point	X = 0.0000,	Y = 1.1444	
Foil Tail Point	X = 3.2442,	Y = 0.0090	
Foil Area (Less Core) = 0.1703			
Gaging	LAMBDA = 1.5786,	X = 2.4360,	Y = 0.6089
Gaging Angle	= 52.876		
Center of Gravity	X = 1.6905,	Y = 0.7876	
Radial Reference	X = 1.7484,	Y = 1.2099	
Inlet Angle	= 90.054		
Exit Angle	= 50.098		
Uncovered Turning	= 10.425		
Constant Section Thickness = .050			

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TABLE LV

SECOND VANE CASCADE TURNING VANE

Radius of 1/4T Section = 9.8437
Pitch = 2.0617

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.3792

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	0.9780	0.9530
0.01	0.0325	0.9780	0.9780
0.02	0.0650	0.9779	0.9779
0.03	0.0975	0.9778	0.9778
0.04	0.1300	0.9776	0.9776
0.05	0.1625	0.9773	0.9773
0.10	0.3250	0.9744	0.9744
0.15	0.4875	0.9692	0.9692
0.20	0.6500	0.9611	0.9611
0.25	0.8125	0.9499	0.9499
0.30	0.9750	0.9351	0.9351
0.35	1.1375	0.9161	0.9161
0.40	1.3000	0.8925	0.8925
0.45	1.4625	0.8637	0.8637
0.50	1.6250	0.8288	0.8288
0.55	1.7875	0.7874	0.7874
0.60	1.9500	0.7388	0.7388
0.65	2.1125	0.6822	0.6822
0.70	2.2750	0.6172	0.6172
0.75	2.4375	0.5435	0.5435
0.80	2.6000	0.4607	0.4607
0.85	2.7625	0.3688	0.3688
0.90	2.9250	0.2677	0.2677
0.95	3.0875	0.1573	0.1573
0.98	3.1850	0.0850	0.0850
0.99	3.2175	0.0601	0.0601
1.00	3.2500	0.0374	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 0.9530,	R = 0.0250
Foil T.E. Circle	X = 3.2250,	Y = 0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 0.9780	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 0.9280	
Foil T.E. Tangency Pt. (Top)	X = 3.2401,	Y = 0.0449	
Foil T.E. Tangency Pt. (Bot)	X = 3.2098,	Y = 0.0051	
Foil Nose Point	X = 0.0,	Y = 0.9530	
Foil Tail Point	X = 3.2449,	Y = 0.0098	
Foil Area (Less Core) = 0.1686			
Gaging Gaging Angle	LAMBDA = 1.7071, = 55.898	X = 2.4622,	Y = 0.5315
Center of Gravity Radial Reference	X = 1.6898, X = 1.7484,	Y = 0.6754 Y = 1.2099	
Inlet Angle	= 90.00		
Exit Angle	= 52.647		
Uncovered Turning	= 11.247		
Constant Section Thickness = .050			

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TABLE LVI

SECOND VANE CASCADE TURNING VANE

Radius of 3/8T Section = 10.2344
Pitch = 2.1435

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.3321

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	0.7902	0.7652
0.01	0.0325	0.7902	0.7902
0.02	0.0650	0.7902	0.7902
0.03	0.0975	0.7901	0.7901
0.04	0.1300	0.7900	0.7900
0.05	0.1625	0.7898	0.7898
0.10	0.3250	0.7883	0.7883
0.15	0.4875	0.7855	0.7855
0.20	0.6500	0.7810	0.7810
0.25	0.8125	0.7747	0.7747
0.30	0.9750	0.7661	0.7661
0.35	1.1375	0.7547	0.7547
0.40	1.3000	0.7401	0.7401
0.45	1.4625	0.7216	0.7216
0.50	1.6250	0.6984	0.6984
0.55	1.7875	0.6695	0.6695
0.60	1.9500	0.6340	0.6340
0.65	2.1125	0.5906	0.5906
0.70	2.2750	0.5387	0.5387
0.75	2.4375	0.4776	0.4776
0.80	2.6000	0.4076	0.4076
0.85	2.7625	0.3289	0.3289
0.90	2.9250	0.2417	0.2417
0.95	3.0875	0.1453	0.1453
0.98	3.1850	0.0818	0.0818
0.99	3.2175	0.0566	0.0566
1.00	3.2500	0.0381	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 0.7652,	R = 0.0250
Foil T.E. Circle	X = 3.2249,	Y = 0.0250,	R = 0.0251
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 0.7902	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 0.7402	
Foil T.E. Tangency Pt. (Top)	X = 3.2392,	Y = 0.0456	
Foil T.E. Tangency Pt. (Bot)	X = 3.2106,	Y = 0.0044	
Foil Nose Point	X = 0.0,	Y = 0.7652	
Foil Tail Point	X = 3.2455,	Y = 0.0107	
Foil Area (Less Core) = 0.1668			
Gaging	LAMBDA = 1.8385,	X = 2.4970,	Y = 0.4530
Gaging Angle	= 59.060		
Center of Gravity	X = 1.6829,	Y = 0.5648	
Radial Reference	X = 1.7484,	Y = 1.2099	
Inlet Angle	= 90.004		
Exit Angle	= 55.224		
Uncovered Turning	= 11.814		
Constant Section Thickness = .050			

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TABLE LVII

SECOND VANE CASCADE TURNING VANE

Radius of Tip Section = 10.6250
Pitch = 2.2253

Axial Chord = 3.2500
No. of Foils = 4

Actual Chord = 3.2963

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	0.6097	0.5847
0.01	0.0325	0.6097	0.6097
0.02	0.0650	0.6097	0.6097
0.03	0.0975	0.6097	0.6097
0.04	0.1300	0.6096	0.6096
0.05	0.1625	0.6096	0.6096
0.10	0.3250	0.6091	0.6091
0.15	0.4875	0.6081	0.6081
0.20	0.6500	0.6065	0.6065
0.25	0.8125	0.6042	0.6042
0.30	0.9750	0.6009	0.6009
0.35	1.1375	0.5963	0.5963
0.40	1.3000	0.5900	0.5900
0.45	1.4625	0.5812	0.5812
0.50	1.6250	0.5692	0.5692
0.55	1.7875	0.5526	0.5526
0.60	1.9500	0.5299	0.5299
0.65	2.1125	0.4993	0.4993
0.70	2.2750	0.4594	0.4594
0.75	2.4375	0.4098	0.4098
0.80	2.6000	0.3516	0.3516
0.85	2.7625	0.2859	0.2859
0.90	2.9250	0.2132	0.2132
0.95	3.0875	0.1324	0.1324
0.98	3.1850	0.0759	0.0759
0.99	3.2175	0.0559	0.0559
1.00	3.2500	0.0388	0.0250
Foil L.E. Circle	X = 0.0250,	Y = 0.5847,	R = 0.0250
Foil T.E. Circle	X = 3.2250,	Y = 0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = 0.6097	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = 0.5597	
Foil T.E. Tangency Pt. (Top)	X = 3.2383,	Y = 0.0462	
Foil T.E. Tangency Pt. (Bot)	X = 3.2116,	Y = 0.0038	
Foil Nose Point	X = 0.0,	Y = 0.5847	
Foil Tail Point	X = 3.2461,	Y = 0.0117	
Foil Area (Less Core) = 0.1657			
Gaging Gaging Angle	LAMBDA = 1.9724, = 62.419	X = 2.5401,	Y = 0.3739
Center of Gravity Radial Reference	X = 1.6755, X = 1.7484,	Y = 0.4536 Y = 1.2099	
Inlet Angle	= 90.018		
Exit Angle	= 57.792		
Uncovered Turning	= 12.138		
Constant Section Thickness = .050			

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TABLE LVIII

SECOND VANE CASCADE TURNING VANE

Radius of Root Section = 7.4600
Pitch = 0.9920

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4356

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9822	-0.9572
0.01	0.0225	-0.9822	-0.9821
0.02	0.0450	-0.9822	-0.9822
0.03	0.0675	-0.9820	-0.9820
0.04	0.0900	-0.9818	-0.9818
0.05	0.1125	-0.9814	-0.9814
0.10	0.2250	-0.9778	-0.9778
0.15	0.3375	-0.9710	-0.9710
0.20	0.4500	-0.9607	-0.9607
0.25	0.5625	-0.9466	-0.9466
0.30	0.6750	-0.9283	-0.9283
0.35	0.7875	-0.9054	-0.9054
0.40	0.9000	-0.8775	-0.8775
0.45	1.0125	-0.8441	-0.8441
0.50	1.1250	-0.8049	-0.8049
0.55	1.2375	-0.7595	-0.7595
0.60	1.3500	-0.7075	-0.7075
0.65	1.4625	-0.6486	-0.6486
0.70	1.5750	-0.5827	-0.5827
0.75	1.6875	-0.5094	-0.5094
0.80	1.8000	-0.4290	-0.4290
0.85	1.9125	-0.3412	-0.3412
0.90	2.0250	-0.2463	-0.2463
0.95	2.1375	-0.1443	-0.1443
0.98	2.2050	-0.0799	-0.0799
0.99	2.2275	-0.0577	-0.0577
1.00	2.2500	-0.0353	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -0.9572,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -0.9822	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -0.9322	
Foil T.E. Tangency Pt. (Top)	X = 2.2426,	Y = -0.0427	
Foil T.E. Tangency Pt. (Bot)	X = 2.2074,	Y = -0.0073	
Foil Nose Point	X = 0.0,	Y = -0.9572	
Foil Tail Point	X = 2.2427,	Y = -0.0074	
Foil Area (Less Core) = 0.1257			
Gaging	LAMBDA = 0.7005,	X = 1.7921	Y = -0.4349
Gaging Angle	= 44.921		
Center of Gravity	X = 1.1744,	Y = -0.6545	
Radial Reference	X = 1.1744,	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 45.154		
Uncovered Turning	= 8.232		
Constant Section Thickness = .050			

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TABLE LIX
SECOND BLADE CASCADE TURNING VANE

Radius of 1/8R Section = 7.9487
Pitch = 1.0570

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4378

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9878	-0.9628
0.01	0.0225	-0.9878	-0.9876
0.02	0.0450	-0.9877	-0.9877
0.03	0.0675	-0.9876	-0.9876
0.04	0.0900	-0.9873	-0.9873
0.05	0.1125	-0.9870	-0.9870
0.10	0.2250	-0.9833	-0.9833
0.15	0.3375	-0.9764	-0.9764
0.20	0.4500	-0.9659	-0.9659
0.25	0.5625	-0.9514	-0.9514
0.30	0.6750	-0.9327	-0.9327
0.35	0.7875	-0.9094	-0.9094
0.40	0.9000	-0.8808	-0.8808
0.45	1.0125	-0.8465	-0.8465
0.50	1.1250	-0.8066	-0.8066
0.55	1.2375	-0.7601	-0.7601
0.60	1.3500	-0.7072	-0.7072
0.65	1.4625	-0.6475	-0.6475
0.70	1.5750	-0.5809	-0.5809
0.75	1.6875	-0.5072	-0.5072
0.80	1.8000	-0.4266	-0.4266
0.85	1.9125	-0.3389	-0.3389
0.90	2.0250	-0.2443	-0.2443
0.95	2.1375	-0.1433	-0.1433
0.98	2.2050	-0.0796	-0.0796
0.99	2.2275	-0.0577	-0.0577
1.00	2.2500	-0.0355	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -0.9628,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = 0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -0.9878	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -0.9378	
Foil T.E. Tangency Pt. (Top)	X = 2.2425,	Y = -0.0428	
Foil T.E. Tangency Pt. (Bot)	X = 2.2076,	Y = -0.0071	
Foil Nose Point	X = 0.0,	Y = -0.9628	
Foil Tail Point	X = 2.2429,	Y = -0.0075	
Foil Area (Less Core) = 0.1273			
Gaging	LAMBDA = 0.7548	X = 1.7657,	Y = -0.4519
Gaging Angle	= 45.567		
Center of Gravity	X = 1.1909,	Y = -0.6490	
Radial Reference	X = 1.1744,	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 45.608		
Uncovered Turning	= 8.306		
Constant Section Thickness = .050			

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TABLE LX

SECOND BLADE CASCADE TURNING VANE

Radius of 1/4R Section = 8.4375
Pitch = 1.1220

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4402

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9936	-0.9686
0.01	0.0225	-0.9936	-0.9935
0.02	0.0450	-0.9935	-0.9935
0.03	0.0675	-0.9934	-0.9934
0.04	0.0900	-0.9931	-0.9931
0.05	0.1125	-0.9928	-0.9928
0.10	0.2250	-0.9892	-0.9892
0.15	0.3375	-0.9825	-0.9825
0.20	0.4500	-0.9722	-0.9722
0.25	0.5625	-0.9580	-0.9580
0.30	0.6750	-0.9394	-0.9394
0.35	0.7875	-0.9160	-0.9160
0.40	0.9000	-0.8874	-0.8874
0.45	1.0125	-0.8530	-0.8530
0.50	1.1250	-0.8125	-0.8125
0.55	1.2375	-0.7655	-0.7655
0.60	1.3500	-0.7117	-0.7117
0.65	1.4625	-0.6509	-0.6509
0.70	1.5750	-0.5830	-0.5830
0.75	1.6875	-0.5082	-0.5082
0.80	1.8000	-0.4264	-0.4264
0.85	1.9125	-0.3380	-0.3380
0.90	2.0250	-0.2432	-0.2432
0.95	2.1375	-0.1423	-0.1423
0.98	2.2050	-0.0790	-0.0790
0.99	2.2275	-0.0574	-0.0574
1.00	2.2500	-0.0355	-0.0250
Foil L.E. Circle	X = 0.0250,	Y = -0.9686,	R = 0.0250
Foil T.E. Circle	X = 2.2250,	Y = -0.0250,	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250,	Y = -0.9936	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250,	Y = -0.9436	
Foil T.E. Tangency Pt. (Top)	X = 2.2424,	Y = -0.0429	
Foil T.E. Tangency Pt. (Bot)	X = 2.2077,	Y = -0.0071	
Foil Nose Point	X = 0.0,	Y = -0.9686	
Foil Tail Point	X = 2.2429,	Y = -0.0076	
Foil Area (Less Core) = 0.1270			
Gaging Gaging Angle	LAMBDA = 0.8071, = 46.003	X = 1.7374	Y = -0.4727
Center of Gravity Radial Reference	X = 1.1933, X = 1.1744,	Y = -0.6515 Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 45.841		
Uncovered Turning	= 8.275		

Constant Section Thickness = .050

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TABLE LXI

SECOND BLADE CASCADE TURNING VANE

Radius of 3/8R Section = 8.9263
Pitch = 1.1870

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4421

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9985	-0.9735
0.01	0.0225	-0.9985	-0.9983
0.02	0.0450	-0.9984	-0.9984
0.03	0.0675	-0.9982	-0.9982
0.04	0.0900	-0.9980	-0.9980
0.05	0.1125	-0.9976	-0.9976
0.10	0.2250	-0.9941	-0.9941
0.15	0.3375	-0.9876	-0.9876
0.20	0.4500	-0.9776	-0.9776
0.25	0.5625	-0.9369	-0.9639
0.30	0.6750	-0.9456	-0.9456
0.35	0.7875	-0.9222	-0.9222
0.40	0.9000	-0.8936	-0.8936
0.45	1.0125	-0.8595	-0.8595
0.50	1.1250	-0.8186	-0.8186
0.55	1.2375	-0.7713	-0.7713
0.60	1.3500	-0.7169	-0.7169
0.65	1.4625	-0.6551	-0.6551
0.70	1.5750	-0.5861	-0.5861
0.75	1.6875	-0.5099	-0.5099
0.80	1.8000	-0.4269	-0.4269
0.85	1.9125	-0.3377	-0.3377
0.90	2.0250	-0.2425	-0.2425
0.95	2.1375	-0.1415	-0.1415
0.98	2.2050	-0.0782	-0.0782
0.99	2.2275	-0.0570	-0.0570
1.00	2.2500	-0.0355	-0.0250
Foil L.E. Circle	X = 0.0250	Y = -0.9735	R = 0.0250
Foil T.E. Circle	X = 2.2250	Y = -0.0250	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250	Y = -0.9985	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250	Y = -0.9485	
Foil L.E. Tangency Pt. (Top)	X = 2.2424	Y = -0.0429	
Foil T.E. Tangency Pt. (Bot)	X = 2.2076	Y = -0.0070	
Foil Nose Point	X = 0.0	Y = -0.9735	
Foil Tail Point	X = 2.2430	Y = -0.0076	
Foil Area (Less Core)	= 0.1252		
Gaging	LAMBDA = 0.8587	X = 1.7080	Y = -0.4953
Gaging Angle	= 46.340		
Center of Gravity	X = 1.1846	Y = -0.6586	
Radial Reference	X = 1.1744	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 45.940		
Uncovered Turning	= 8.303		
Constant Section Thickness	= .050		

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TABLE LXII

SECOND BLADE CASCADE TURNING VANE

Radius of Mean Section = 9.4150
Pitch = 1.2520

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4412

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9960	-0.9710
0.01	0.0225	-0.9960	-0.9959
0.02	0.0450	-0.9959	-0.9959
0.03	0.0675	-0.9958	-0.9958
0.04	0.0900	-0.9955	-0.9955
0.05	0.1125	-0.9951	-0.9951
0.10	0.2250	-0.9910	-0.9910
0.15	0.3375	-0.9835	-0.9835
0.20	0.4500	-0.9721	-0.9721
0.25	0.5625	-0.9566	-0.9566
0.30	0.6750	-0.9365	-0.9365
0.35	0.7875	-0.9115	-0.9115
0.40	0.9000	-0.8814	-0.8814
0.45	1.0125	-0.8457	-0.8457
0.50	1.1250	-0.8041	-0.8041
0.55	1.2375	-0.7563	-0.7563
0.60	1.3500	-0.7022	-0.7022
0.65	1.4625	-0.6416	-0.6416
0.70	1.5750	-0.5743	-0.5743
0.75	1.6875	-0.5005	-0.5005
0.80	1.8000	-0.4201	-0.4201
0.85	1.9125	-0.3333	-0.3333
0.90	2.0250	-0.2402	-0.2402
0.95	2.1375	-0.1410	-0.1410
0.98	2.2050	-0.0785	-0.0785
0.99	2.2275	-0.0572	-0.0572
1.00	2.2500	-0.0356	-0.0250
Foil L.E. Circle	X = 0.0250	Y = -0.9710	R = 0.0250
Foil T.E. Circle	X = 2.2250	Y = -0.0250	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250	Y = -0.9960	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250	Y = -0.9460	
Foil T.E. Tangency Pt. (Top)	X = 2.2423	Y = -0.0430	
Foil T.E. Tangency Pt. (Bot)	X = 2.2077	Y = -0.0069	
Foil Nose Point	X = 0.0	Y = -0.9710	
Foil Tail Point	X = 2.2431	Y = -0.0077	
Foil Area (Less Core)	= 0.1235		
Gaging	LAMBDA = 0.9194	X = 1.6902	Y = -0.4987
Gaging Angle	= 47.251		
Center of Gravity	X = 1.1761	Y = -0.6543	
Radial Reference	X = 1.1744	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 46.216		
Uncovered Turning	= 9.301		
Constant Section Thickness = .050			

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TABLE LXIII
SECOND BLADE CASCADE TURNING VANE

Radius of 1/8T Section = 9.9038
Pitch = 1.3170

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4350

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9800	-0.9550
0.01	0.0225	-0.9800	-0.9799
0.02	0.0450	-0.9801	-0.9801
0.03	0.0675	-0.9798	-0.9798
0.04	0.0900	-0.9793	-0.9793
0.05	0.1125	-0.9791	-0.9791
0.10	0.2250	-0.9731	-0.9731
0.15	0.3375	-0.9628	-0.9628
0.20	0.4500	-0.9471	-0.9471
0.25	0.5625	-0.9257	-0.9257
0.30	0.6750	-0.9007	-0.9007
0.35	0.7875	-0.8717	-0.8717
0.40	0.9000	-0.8371	-0.8371
0.45	1.0125	-0.7966	-0.7966
0.50	1.1250	-0.7538	-0.7538
0.55	1.2375	-0.7048	-0.7048
0.60	1.3500	-0.6526	-0.6526
0.65	1.4625	-0.5966	-0.5966
0.70	1.5750	-0.5359	-0.5359
0.75	1.6875	-0.4704	-0.4704
0.80	1.8000	-0.3991	-0.3991
0.85	1.9125	-0.3205	-0.3205
0.90	2.0250	-0.2338	-0.2338
0.95	2.1375	-0.1400	-0.1400
0.98	2.2050	-0.0804	-0.0804
0.99	2.2275	-0.0585	-0.0585
1.00	2.2500	-0.0359	-0.0250
Foil L.E. Circle	X = 0.0250	Y = -0.9550	R = 0.0250
Foil T.E. Circle	X = 2.2250	Y = -0.0250	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250	Y = -0.9800	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250	Y = -0.9300	
Foil T.E. Tangency Pt. (Top)	X = 2.2420	Y = -0.0433	
Foil T.E. Tangency Pt. (Bot)	X = 2.2081	Y = -0.0067	
Foil Nose Point	X = 0.0	Y = -0.9550	
Foil Tail Point	X = 2.2434	Y = -0.0081	
Foil Area (Less Core) = 0.1233			
Gaging	LAMBDA = 0.9991	X = 1.6900	Y = -0.4673
Gaging Angle	= 49.341		
Center of Gravity	X = 1.1774	Y = -0.6253	
Radial Reference	X = 1.1744	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 47.193		
Uncovered Turning	= 11.621		
Constant Section Thickness = .050			

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TABLE LXIV

SECOND BLADE CASCADE TURNING VANE

Radius of 1/4T Section = 10.3925
Pitch = 1.3820

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.4239

Percent "	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9500	-0.9250
0.01	0.0225	-0.9500	-0.9499
0.02	0.0450	-0.9500	-0.9500
0.03	0.0675	-0.9497	-0.9497
0.04	0.0900	-0.9490	-0.9490
0.05	0.1125	-0.9490	-0.9490
0.10	0.2250	-0.9410	-0.9410
0.15	0.3375	-0.9280	-0.9280
0.20	0.4500	-0.9080	-0.9080
0.25	0.5625	-0.8810	-0.8810
0.30	0.6750	-0.8510	-0.8510
0.35	0.7875	-0.8180	-0.8180
0.40	0.9000	-0.7790	-0.7790
0.45	1.0125	-0.7340	-0.7340
0.50	1.1250	-0.6900	-0.6900
0.55	1.2375	-0.6400	-0.6400
0.60	1.3500	-0.5900	-0.5900
0.65	1.4625	-0.5390	-0.5390
0.70	1.5750	-0.4850	-0.4850
0.75	1.6875	-0.4280	-0.4280
0.80	1.8000	-0.3670	-0.3670
0.85	1.9125	-0.2980	-0.2980
0.90	2.0250	-0.2200	-0.2200
0.95	2.1375	-0.1350	-0.1350
0.98	2.2050	-0.0807	-0.0807
0.99	2.2275	-0.0590	-0.0590
1.00	2.2500	-0.0366	-0.0250
Foil L.E. Circle	X = 0.0250	Y = -0.9250	R = 0.0250
Foil T.E. Circle	X = 2.2250	Y = -0.0250	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250	Y = -0.9500	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250	Y = -0.9000	
Foil T.E. Tangency Pt. (Top)	X = 2.2411	Y = -0.0441	
Foil T.E. Tangency Pt. (Bot)	X = 2.2089	Y = -0.0059	
Foil Nose Point	X = 0.0	Y = -0.9250	
Foil Tail Point	X = 2.2441	Y = -0.0089	
Foil Area (Less Core)	= 0.1233		
Gaging	LAMBDA = 1.0916	X = 1.7063	Y = -0.4182
Gaging Angle	= 52.175		
Center of Gravity	X = 1.1799	Y = -0.5841	
Radial Reference	X = 1.1744	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 49.803		
Uncovered Turning	= 12.472		
Constant Section Thickness = .050			

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TABLE LXV

SECOND BLADE CASCADE TURNING VANE

Radius of 3/8T Section = 10.8812
Pitch = 1.4470

Axial Chord = 2.2500
No. of Foils = 4

Axial Chord = 2.4083

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.9066	-0.8816
0.01	0.0225	-0.9066	-0.9065
0.02	0.0450	-0.9063	-0.9063
0.03	0.0675	-0.9060	-0.9060
0.04	0.0900	-0.9052	-0.9052
0.05	0.1125	-0.9053	-0.9053
0.10	0.2250	-0.8965	-0.8965
0.15	0.3375	-0.8831	-0.8831
0.20	0.4500	-0.8618	-0.8618
0.25	0.5625	-0.8346	-0.8346
0.30	0.6750	-0.8031	-0.8031
0.35	0.7875	-0.7692	-0.7692
0.40	0.9000	-0.7292	-0.7292
0.45	1.0125	-0.6837	-0.6837
0.50	1.1250	-0.6396	-0.6396
0.55	1.2375	-0.5899	-0.5899
0.60	1.3500	-0.5407	-0.5407
0.65	1.4625	-0.4913	-0.4913
0.70	1.5750	-0.4389	-0.4389
0.75	1.6875	-0.3842	-0.3842
0.80	1.8000	-0.3283	-0.3283
0.85	1.9125	-0.2655	-0.2655
0.90	2.0250	-0.1963	-0.1963
0.95	2.1375	-0.1222	-0.1222
0.98	2.2050	-0.0763	-0.0763
0.99	2.2275	-0.0570	-0.0570
1.00	2.2500	-0.0379	-0.0252
Foil L.E. Circle	X = 0.0250	Y = -0.8816	R = 0.0250
Foil T.E. Circle	X = 2.2253	Y = -0.0252	R = 0.0247
Foil L.E. Tangency Pt. (Top)	X = 0.0250	Y = -0.9066	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250	Y = -0.8566	
Foil T.E. Tangency Pt. (Top)	X = 2.2396	Y = -0.0453	
Foil T.E. Tangency Pt. (Bot)	X = 2.2106	Y = -0.0053	
Foil Nose Point	X = 0.0	Y = -0.8816	
Foil Tail Point	X = 2.2453	Y = -0.0107	
Foil Area (Less Core)	= 0.1219		
Gaging	LAMBDA = 1.1889	X = 1.6936	Y = -0.3812
Gaging Angle	= 55.250		
Center of Gravity	X = 1.1722	Y = -0.5467	
Radial Reference	X = 1.1744	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 54.084		
Uncovered Turning	= 9.389		
Constant Section Thickness = .050			

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TABLE LXVI

SECOND BLADE CASCADE TURNING VANE

Radius of Tip Section = 11.3700
Pitch = 1.5120

Axial Chord = 2.2500
No. of Foils = 4

Actual Chord = 2.3885

Percent X	Foil X	Foil Y (Top)	Foil Y (Circle)
0.0	0.0	-0.8500	-0.8250
0.01	0.0225	-0.8500	-0.8499
0.02	0.0450	-0.8490	-0.8490
0.03	0.0675	-0.8489	-0.8489
0.04	0.0900	-0.8480	-0.8480
0.05	0.1125	-0.8480	-0.8480
0.10	0.2250	-0.8400	-0.8400
0.15	0.3375	-0.8290	-0.8290
0.20	0.4500	-0.8100	-0.8100
0.25	0.5625	-0.7890	-0.7890
0.30	0.6750	-0.7600	-0.7600
0.35	0.7875	-0.7290	-0.7290
0.40	0.9000	-0.6920	-0.6920
0.45	1.0125	-0.6510	-0.6510
0.50	1.1250	-0.6080	-0.6080
0.55	1.2375	-0.5600	-0.5600
0.60	1.3500	-0.5100	-0.5100
0.65	1.4625	-0.4580	-0.4580
0.70	1.5750	-0.4010	-0.4010
0.75	1.6875	-0.3410	-0.3410
0.80	1.8000	-0.2840	-0.2840
0.85	1.9125	-0.2230	-0.2230
0.90	2.0250	-0.1620	-0.1620
0.95	2.1375	-0.1010	-0.1010
0.98	2.2050	-0.0647	-0.0647
0.99	2.2275	-0.0520	-0.0520
1.00	2.2500	-0.0400	-0.0263
Foil L.E. Circle	X = 0.0250	Y = -0.8250	R = 0.0250
Foil T.E. Circle	X = 2.2264	Y = -0.0263	R = 0.0250
Foil L.E. Tangency Pt. (Top)	X = 0.0250	Y = -0.8500	
Foil L.E. Tangency Pt. (Bot)	X = 0.0250	Y = -0.8000	
Foil T.E. Tangency Pt. (Top)	X = 2.2381	Y = -0.0468	
Foil T.E. Tangency Pt. (Bot)	X = 2.2136	Y = -0.0064	
Foil Nose Point	X = 0.0	Y = -0.8250	
Foil Tail Point	X = 2.2466	Y = -0.0140	
Foil Area (Less Core)	= 0.1190		
Gaging	LAMBDA = 1.2864	X = 1.6053	Y = -0.3848
Gaging Angle	= 62.0		
Center of Gravity	X = 1.1513	Y = -0.5165	
Radial Reference	X = 1.1744	Y = -0.6545	
Inlet Angle	= 90.000		
Exit Angle	= 62.0		
Uncovered Turning	= 1.452		
Constant Section Thickness	= .050		

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REFERENCES

1. H. Welna, D.E. Dahlberg and W.H. Heiser; (Unclassified) Investigation of a Highly Loaded Two-Stage Fan-Drive Turbine; Interim Technical Status Report; Pratt & Whitney Aircraft Division of United Aircraft Corporation; 28 June 1968; Confidential

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13. ABSTRACT <p>(U) A comprehensive three-year program is in progress to investigate methods of improving the performance of fan-drive turbines. The goals of the program are to develop turbine aerodynamic techniques and design procedures for efficient, high work, low pressure turbines by means of analytical studies and cascade testing, and to demonstrate the effectiveness of the techniques by designing and testing a two stage turbine that meets or exceeds the contract stage work and efficiency goals. The first phase effort defining the preliminary turbine design has been completed and the results have been reported. The second phase consists of a preliminary experimental evaluation which includes establishment of two-dimensional loss levels and three-dimensional flow behavior for both the baseline airfoils and airfoils utilizing boundary layer control devices. The design of the rig hardware and the baseline airfoils which will be evaluated during this second phase are presented in this report.</p> <p>Distribution of this abstract is unlimited.</p>			

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